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1. SCOPE.

1.1 Scope.- This specification establishes the requirements for the design, development, construction, performance, testing, installation, and system integration of a solid-state receiver and digital moving target indicator (SSR/DMTI) modification kit to replace vacuum tubes and associated circuitry in the receiver subsystem of vacuum-tube air route surveillance radars (VT ARSR) with solid-state devices and digital circuitry to improve reliability and maintainability, to improve system performance and to improve the operating efficiency of the receiver system. The SSR/DMTI modification kit will apply to the following VT ARSR radar systems:

(a) ARSR-1, -2 series long-range radars
(b) FPS-20 series family of long-range radars consisting of the following models:

(1) Single Modulator Systems

a	AN/FPS-20A	e	AN/FPS-87A
b	AN/FPS-66A	f	AN/FPS-91A
c	AN/FPS-67A	g	AN/FPS-93A
d	AN/FPS-67B	h	AN/FPS-60 ( )
		i	ARSR-60

(2) Dual Modulator Systems

a	AN/FPS-64A
b	AN/FPS-65A

The modifications will be implemented in a manner that will not reduce 'the operational capability of military or the Federal Aviation Administration (FAA) use outputs. The SSR/DMTI kit for the ARSR-1, -2 series and FPS-20 family of radars will be identical with appropriate adaptation for interface requirements and varying pulse widths (2 microseconds (us) for ARSR-1, -2 series and 3 and 6 us for FPS-20 family of radars). SSR/DMTI will interface with remote radar weather display system (RRWDS), radio microwave link terminal equipment (RMLT), height finder military radar (FPS-6/90), beacon (ATCRBS), and common digitizer equipment (CD-2 series, AN/FYQ-47, AN/FYQ-49).

In both basic radar types, the original receiver front-end components have been replaced by the Government. Newer radio frequency (rf) amplifier mixer assemblies, variable sensitivity time control (stc) attenuation, and transmit receive (tr) limiter assemblies are installed and will be retained by the new SSR/DMTI modification kit. All other existing receiver equiqment in each channel will be replaced including the stable local oscillator (STALO), coherent oscillator (COHO), synchronizer and trigger distribution. The existing MTI systems shall be replaced with a digital MTI.

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CCA	Circuit Card Assembly. A moderately complex assembly of discrete parts consisting of active and passive electronic components, their interconnecting wire or printed circuit wiring conductors, connectors, mounting hardware and similar pieces which are operated and maintained as a unit. In this specification, CCAs include both wired-in and plug-in assemblies which use either printed wiring techniques or point-to-point wiring. They generally consist of a flat nonconducting baseboard on which the electronic components are mounted and which serves as a major structural element. Thus, a power supply with large transformers, heat sinks, and regulators on a metal chassis is not a CCA, even if it is a plug-in assembly. Digital logic boards as well as those incorporating linear or discrete semiconductor components are CCAs regardless of the method used to interconnect the components. Backplanes and mother boards into which plug-in assemblies are inserted are not CCA if they contain only resistors, capacitors, and interconnecting cable and wiring.
CD-2	Common Digitizer-2. This is a second generation common digitizer. Unless otherwise noted in the particular context, or unless obviously not applicable, the term "CD-2" shall apply to the two CD-2 configurations defined herein.
CD-2A	The long-range, FAA version of the CD-2 which provides search, beacon, and weather data to FAA users.
CD-2C	The long-range, joint-use (common) version of the CD-2 which provides search, beacon, and weather data to FAA users, and search, beacon, AIMS, and height finder data to Air Defense Command users.
Clutter	The echoes or returns from a search radar which do not represent the desired information. For aircraft detection purposes, ground, sea, and weather returns qualify as clutter.
CP	Circular Polarization. A technique used by search radars to eliminate or separate weather returns from target returns.
Digital	Pertaining to data in the form of digits, as in a series of pulses. The term also refers to the equipment which uses digital signals to a great extent in its internal circuitry.

Equipment	An electronic apparatus which is capable of performing its assigned functions with minimal support from other units. In this specification, the SSR/DMTI, the associated radar sets and similar units are defined as equipments.
FAA	Federal Aviation Administration
Fall Time	The time required for a digital signal to decline from its active state to its inactive state. It is measured from the time the signal amplitude reaches 90 percent of its steady state active value to the time it reaches 10 percent of that value. For a positive pulse in a positive logic system, the fall time is measured on the downward sloping edge of the pulse.
Metric System	The international system of weights and measures, also known as the SI system. In general, the linear dimensions herein will be specified in English units with the metric equivalent in parentheses; target range is a major exception (see nautical mile). Temperature will be given in degrees Celsius only. In all instances where the two systems are used to specify a value, the first one given will be the value intended and the second measure is for information only. No added precision is intended from additional significant figures which may be present in the second equivalent expression.
MTBF	Mean Time Between Failure. For a particular interval, the functioning life of a population of an item divided by the total number of equipment and functional failures within the population during the measurement interval.
MTBO	Mean Time Between Outages. The average time that a particular equipment or system, including any redundant elements, will continue to provide correct, reliable operation or data to a defined user.
MTD	Moving Target Detector. A radar processor subsystem employing digital storage and analysis of receiver signals by means of Doppler filtering, constant false alarm rate sensing, and clutter/interference editing to enhance the display of moving targets.
MTI	Moving Target Indicator.
MTTR	Mean Time To Restore. The mean time required to restore a failed function to an operational condition. The function may be restorable by corrective maintenance repair, substitution of modules, board replacement, or the activation of a redundant element.

MBRT — Mean Bench Repair Time. The mean time required to repair Tailed itemwhich has been removed from the system.

Nautical Mile — The unit of linear distance most often used in sea, air, and space navigation. Throughout this specification, the terms mile and nautical mile (and its abbreviation nmi) will be used interchangeably and shall be equal to 6076.12 feet (1.852 km).

NAS — National Airspace System. A term used to denote the FAA's air traffic control system in general.

PROM — Progammable Read Only Memory integrated circuit chip. A PROM is a semiconductor memory chip which is normally filled with the appropriate data (programmed) once during the design and programming of its associated microprocessor. It is then used only as a source of data by the processor to control its operation or to provide specific, unchanging data in response to a given request. Its data content is permanent in normal equipment operation. The programming of the chip may be able to be accomplished only once, as in a fusible link PROM, or may be able to be repeatedly changed using appropriate external equipment and techniques. PROM's with this latter capability are usually identified as EPROM's (electrically programmable read only memories).

Pulse Width — The duration of a pulse as measured at the 50 percent amplitude points.

Radar — Electronic surveillance equipment which transmits radio-frequency energy and receives echoes of that energy (search) or retransmissions triggered by that energy (beacon) for the purpose of establishing the location of aircraft and weather targets. The term, as used in this specification, may denote either search or beacon radar or both, depending on its context.

Radar Mile — The time it takes for radio frequency energy to travel 2 nautical miles (1 mile out and 1 mile back). Numerically, it is equal to 12.359 microseconds.

RAM — Random Access Memory. A RAM is a semiconductor memory chip, or a memory composed of such chips, which can be written into and read out of in a randomly addressable pattern under control of a processing element. It is used as a temporary storage for data which must be available within a very short access time. It may be either dynamic (refreshed) or static; both are volatile in that the data is lost when power is removed.

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Test Target	A test target resulting from test signals injected anywhere in the radar receiver digitizer chain. It can be a search, beacon, or weather target.
us	In this specification, "us" is used as an abbreviation for "microsecond."
Voltage	All signal and SSR/DMTI power supply output voltages are specified with respect to the SSR/DMTI signal ground.
VT ARSR	Vacuum-tube air route surveillance radars consisting of the ARSR-1, -2 series of long-range radars and the FPS-20 family of long-range radars.
Will	A verb which denotes intended or future actions or capabilities which are not requirements of this specification.
Word	A group of pulses or the bits of information they represent which are acted upon, treated, and processed as a group. Normally, the term applies to the internal manipulation and organization of information in a digital computer.

2. APPLICABLE DOCUMENTS.

2.1 FAA documents.- The following FAA specifications, standards, and publications, of the issues in effect on the date of the invitation for bids or request for proposals, form a part of this specification and are appliable to the extent specified herein.

2.1.1 FAA specifications.-

FAA-D-2494, Part 1	Instruction Book, Manuscripts, Technical; Equipment and Systems Requirements, Preparation of Manuscripts
FAA-D-2494, Part 2	Instruction Book, Manuscripts, Technical; Equipment and Systems Requirements, Preparation of Reproducible Copy
FAA-G-1210	Provisioning Technical Documentation
FAA-G-1375	Spare Parts-Peculiar for Electronic, Electrical, and Mechanical Equipment
FAA-G-2100	Electronic Equipment, General Requirements
FAA-E-2552	Technical Training
FAA-E-2679	Common Digitizer, CD-2

2.1.2 FAA standards.-

FAA-STD-002 Engineering Drawings

FAA-STD-007 Program Evaluation Review Techniques (PERT) Procedures for Contract Use

FAA-STD-010 Graphic Symbols for Digital Logic Equipment

FAA-STD-012 Paint Systems for Equipment

FAA-STD-013 Quality Control Program Requirements

FAA-STD-019 Lightning Protection Grounding, Bonding and Shielding Requirements for Facilities

FAA-STD-020 Transient Protection, Grounding, Bonding and Shielding Requirements for Equipment

FAA-STD-021 Configuration Management (Contractor Requirements)

FAA-STD-025 Preparation of Interface Control Documents

2.1.3 FAA publications.-

FAA Order 1800.8, National Airspace System Configuration Management

FAA Order 6340.6 Maintenance of AN/FPS-20 Family of Radars

FAA Order 6340.8 Maintenance of Air Route Surveillance Radar (ARSR) Facilities

FAA Order 6340.19 Maintenance of Air Route Surveillance Radar, ARSR-60 Family of Radars

2.2 Military and Federal publications.- The following military and federal publications, of the issues in effect on the date of the invitation for bids or request for proposals, form a part of this specification and are applicable to the extent specified herein.

2.2.1 Military specifications.-

MIL-E-17555 Electronic and Electrical Equipment Accessories and Repair Parts, Packaging and Packing Of

2.2.2 Military standards.-

MIL-STD-275 Printed Wiring for Electronic Equipment

MIL-STD-454 Standard General Requirements for Electronic Equipment

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MIL-STD-275 Printed Wiring for Electronic Equipment

MIL-STD-454 Standard General Requirements for Electronic Equipment

FIPS PUB 38 Guidelines for Documentation of Computer Programs and Automated Data Systems

2.4 Sources of documents.-

2.4.1 FAA documents.- Copies of the applicable FAA specifications and drawings and other publications whose sources are not identified in the following paragraphs may be obtained from the Federal Aviation Administration, 800 Independence Avenue, SW., Washington, D.C. 20591, Attention: Contracting Officer. Requests should fully identify the material desired; use specification numbers, dates, amendment numbers, and complete drawing numbers. The request should also identify the invitation for bids, request for proposals, or contract involved, or other use to be made of the requested material.

2.4.2 Military documents.- Single copies of the military specifications, standards, and publications may be obtained from the Naval Publications and Form Center, 5801 Tabor Avenue, Phildadelphia, Pennsylvania 19120. The RADC Nonelectronic Reliability Notebook may be obtained from the National Technical Information Service, U.S. Department of Commerce, 5285 Port Royal Road, Springfield, Virginia 22161, telephone number 703/557-4650. Mailed requests should cite the invitation for bids, request for proposals, or contract for which materials are needed.

2.4.3 Federal documents.- Information on obtaining copies of federal specifications and standards may be obtained from the General Services Administration Offices in Washington, D.C.; Auburn, Washington; San Franciso, California; Denver, Colorado; Kansas City, Missouri; Atlanta, Georgia; Chicago, Illinois; New York, New York; Boston, Massachusetts; New Orleans, Louisiana; Fort Worth, Texas; and Los Angeles, California.

2.4.4 National electrical code.- Information on obtaining copies of the National Electrical Code may be obtained from the National Fire Protection Association, 470 Atlantic Avenue, Boston, Massachusetts 02210.

2.4.5 American National Standards Institute, Inc., publications.- Requests for obtaining copies of ANSI publications should be directed to the American National Standards Institute, Inc., 1430 Broadway, New York, New York 10018.

2.5 Instruction manuals for associated equipment.- Manuals for equipments interfacing with the SSR/DMTI modification kit, including maintenance and modification manuals, form a part of this specification to the extent specified herein. These manuals will not be furnished for the preparation of proposals. However, reference copies will be available in the Department of Transportation Library, Federal Aviation Administration, 800 Independence Avenue, SW., Washington, D.C. 20591.

2.6 Precedence of documents.- If the requirements of the contract, this specification, or subsidiary documents are in conflict, the following precedence shall apply:

(a) Contract - The contract shall have precedence over all other documents.

(b) Specification - This specification shall have precedence over all subsidiary documents referenced herein.

3. REQUIREMENTS.-

3.1 General.- The contractor shall provide all of the services and materials necessary to design, develop, fabricate, test, deliver, install, interface, and checkout the equipments required by this specification and the contract on a turnkey basis. It shall supply the major deliverable items tabulated below in the quantities and at the times required by the contract. Any feature or items necessary to achieve the operation and performance required by this specification shall be incorporated or furnished even through such feature or item is not specifically defined or described herein. The contractor shall provide all services and materials necessary to prepare, reproduce and provide engineering analyses, reports, instruction books, and other documentation as specified herein.

The SSR/DMTI modification kit shall accept the required input signals and shall meet the specified requirements. The contractor shall be responsible for the detailed design of the circuitry in the SSR/DMTI modification equipment which receives signals from and provides signals to the ARSR-1, -2, or the FPS-20 family of radars, as appropriate, and to the military or the FAA use outputs with which it is interconnected, subject to the limitations contained herein. No modification of the interconnecting equipment or its software (including that at the using FAA facilities) shall be required or permitted to accommodate installation and operation of the SSR/DMTI modification kit. There are two exception to this requirement. For the ARSR-1, -2 series of radars, automatic frequency control (AFC) may be applied to the magnetron transmitter. For the stagger function, the contractor shall identify the stagger length and sequence within one microsecond or better; the Government will use this information to program the CD-2 search extractor timing circuitry to maintain synchronism.

3.1.1 Operational equipment to be furnished by the contractor.- The SSR/DMTI modification kit shall be furnished in up to three configurations as required by the contract. The equipment shall be designed for maximum commonality of modules among the three configurations."

3.1.1.1 SSR/DMTI Type I Modification Kit.- The Type I kit shall be the configuration of the SSR/DMTI which receives signals from and provides signals to the ARSR-1, -2 series long-range search and beacon radar equipment, and to the military and FAA use outputs. It shall consist of the following modules, documentation, and installation materials.

(a) Receiver group (two each) performing the following functions:

(1) IF distribution amplifier/filter
(2) Solid-state log receiver/processor
(3) Solid-state MTI I&Q receivers
(4) I&Q digital moving target indicator processor
(5) DMTI lag circuit
(6) Synchronizer
(7) STC waveform generator
(8) Video and trigger distribution amplifiers
(9) Manual and auto built-in test equipment (BITE)

(b) Solid-state coherent oscillator (COHO) (two each) with phase locking circuitry.

(c) Solid-state stable local oscillator (STALO) (two each)

(d) IF preamplifier (two each)

(e) Modification documentation (one lot)

(f) Installation material and cable (one lot)

3.1.1.2 SSR/DMTI Type II Modification Kit.- The Type II kit shall be the configuration of the SSR/DMTI which receives signals from and provides signals to the FPS-20 family of long-range search and beacon radar equipments and to the military and FAA use outputs. It shall consists of the following modules, documentation, and installation materials:

(a) Receiver group (two each) performing the following functions:

(1) IF distribution amplifier/filter
(2) Solid-state log receiver/processor
(3) Solid-state MTI I&Q receivers
(4) I&Q digital moving tan-get indicator processor
(5) DMTI log circuit
(6) Synchronizer
(7) STC waveform generator
(8) Video and trigger distribution amplifiers
(9) Manual and auto built-in test equipment (BITE)
(10) ACP/ARP processor

(b) Solid-state coherent oscillator (COHO) (two each).

(c) Solid-state stable local oscillator (STALO) (two each).

(d) IF preamplifier (two each).

(e) Modification documentation (one lot).

(f) Installation material and cable (one lot).

3.1.1.3 SSR/DMTI Type III Modification Kit.- The Type III kit shall be the configuration of the SSR/DMTI to be used at th ARSR-60 long-range search and beacon radar equipment at Trevose, Pennsylvania. The Type III kit shall be identical to the Type II kit with the exception that it shall operate with a three microsecond pulse width. It shall consists of the following modules, documentation, and installation materials,

(a) Receiver group (two each) performing the following functions:

(1) IF distribution amplifier/filter
(2) Solid-state log receiver/processor
(3) Solid-state MTI I&Q receivers
(4) I&Q digital moving target indicator processor
(5) DMTI log circuit
(6) Synchronizer
(7) STC waveform generator
(8) Video and trigger distribution amplifiers
(9) Manual and auto built-in test equipment (BITE)
(10) ACP/ARP processor

(b) Solid-state coherent oscillator (COHO) (two each),

(c) Solid--state stable local oscillator (STALO) (two each) with pulse output capability.

(d) IF preamplifier (two each).

(e) Modification documentation (one lot>.

(f) Installation material and cable (one lot).

3.1.2 Support equipment to be furnished by the contractor as required by the contract.-

(a> Plug-in assembly extender (three for each type per site).
(b) Test discs, and adapters for Autek test set,
(c) Special tools and ancillary items.

3.1.3 Documentation to be furnished by the contractor as required by the contract.-

3.1.3.1 System documentation.-

(a) Management reports.
(b) System design data.
(c) Qualification and Acceptance Test Plan.
(d) Equipment and. computer program test procedures.
(e) Test reports.
(f) Site preparation reports.
(g) Install.at ion documentation.

3.1.1.3 SSR/DMTI Type III Modification Kit.- The Type III kit shall be the configuration of the SSR/DMTI to be used at th ARSR-60 long-range search and beacon radar equipment at Trevose, Pennsylvania. The Type III kit shall be identical to the Type II kit with the exception that it shall operate with a three microsecond pulse width. It shall consists of the following modules, documentation, and installation materials,

(a) Receiver group (two each) performing the following functions:

(1) IF distribution amplifier/filter
(2) Solid-state log receiver/processor
(3) Solid-state MTI I&Q receivers
(4) I&Q digital moving target indicator processor
(5) DMTI log circuit
(6) Synchronizer
(7) STC waveform generator
(8) Video and trigger distribution amplifiers
(9) Manual and auto built-in test equipment (BITE)
(10) ACP/ARP processor

(b) Solid-state coherent oscillator (COHO) (two each),

(c) Solid-state stable local oscillator (STALO) (two each) with pulse output capability.

(d) IF preamplifier (two each).

(e) Modification documentation (one lot).

(f) Installation material and cable (one lot).

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(e) Test reports.
(f) Site preparation reports.
(g) Installation documentation.

3.4 General requirements.- The basis of the overall equipment design and modification shall be the achievement of maximum operational reliability and ease of servicing. The contractor shall utilize solid-state devices in the modification kits. All pulse width requirements not otherwise specified herein shall be measured at the 50 percent amplitude point. Timing accuracy between pulses shall be measured using the leading edge 50 percent amplitude point with the rf pulse input level at a point where limiting begins to occur on the normal video output.

The installed modification kit shall be capable of operation in an environment which includes adjacent high power radar installations and it shall not degrade the performance of the system throughout the range of service conditions specified in paragraph 3.5.2 and succeeding paragraphs.

The equipment shall include features such that it is electrically and mechanically impossible to install incorrectly its modules or circuit cards assemblies (3.6.27.5.7.5.1).

All assemblies, subassemblies, printed circuit boards, wiring, etc., supplied as part of the modification shall conform to the requirements of FAA-G-2100 specification except where the contractor submits proposals and obtains FAA approval which justify the nonconformance with FAA-G-2100 due to incompatibility with the equipment being modified.

New assemblies supplied by the contractor shall be in a cabinet separate from the existing ARSR-1, -2, or FPS-20 family of radars, as appropriate, except for the Stable Local Oscillator (STALO), Coherent Oscillator (COHO), and front-end modification, with a minimum of interconnection to existing equipment. Equipment electrically isolated from each radar channel shall be provided.

3.5 Environmental requirements.- The SSR/DMTI will be installed at fixed ground-based radar sites located throughout the entire United States. Some locations will be remote facilities with locally generated power. The design of the SSR/DMTI shall be such that the required performance is achieved over the environmental conditions specified in he following paragraphs:

3.5.1 Ground clutter.- Returns from the terrain surrounding the radar site vary from site-to-site and may, under conditions of ducting or anomalous propogation (AP), extend to the full range of the radar. The strength of the ground clutter is 60 to 85 dB above the weakest signal detectable by the radar's receiver. Generally, the ground clutter will have range extent or azimuth extent or both which are greater than that of an aircraft return.

3.5.2 Service conditions.- The SSR/DMTI shall be designed to meet the service conditions described in the following paragraphs:

3.5.2.1 Operating environment.- The SSR/DMTI shall meet all functional and performance requirements specified herein under the enviornmental conditions of FAA-G-2100, paragraph 3.2.15 for environment II, in continuous, unattended duty at altitudes from sea level to 10,000 feet (3657.6 m) above sea level. The standard design center value for ambient temperature shall be +30 degrees Celsius (C).

3.5.2.2 Operating electrical conditions.- The SSR/DMTI and its supporting equipment shall be designed using the following design center values and shall meet all functional and performance requirements specified herein when operating from a primary power source with the following service condition range values:

Source Parameter	Service Condition Range
120 v design center, single phase	102 to 138 v
208 V design center, three phase	177 to 239 v
60 Hz design center frequency	47 to 63 Hz

3.5.2.2.1 Electrical transients.- All function and performance requirements shall be met under conditions listed in FAA-G-2100, paragraph 3.3.2.5 as modified below:

(a> Paragraph 3.2.2.5, is qualified by defining the "slowing varying" AC line voltage as changing at the rate of 5.0 V/s or less.

(b) Paragraph 3.2.2.5, is qualified by defining the "slowly varying" AC line frequency as changing at the rate of 1.0 Hz/s or less.

3.5.2.2.1.1 AC line overvoltage transient.- The SSR/DMTI shall meet all functional and performance requirement withstand, without operational interruption or malfunction, and without damage while withstanding a transient increase in the AC line voltage superimposed for as long as 50 milliseconds on the AC line voltage waveforms, and reaching a peak voltage which is 150 percent of the peak value of the design center AC line voltage. For three phase supplies, this overvoltage condition applies to the most severly disturbed phase-to-phase voltage, with the disturbance on the other two phase-to-phase voltage not exceeding 150 percent, but being otherwise unspecified. Should the SSR/DMTI shutdown as a result of a transient exceeding these limits, the SSR/DMTI shall restart automatically within 30 seconds when the line overvoltage condition terminates.

3.5.2.2.1.2 AC line undervoltage transient.- The SSR/DMTI shall withstand, without operational interruption or malfunction, and without damage a partial or complete loss of line voltage for up to 16 milliseconds at a time, recurring no more than once every 60 seconds. For three phase supplies, this partial or complete loss of voltage may affect one, two, or all three phase-to-phase voltage simultaneously. Should the partial or complete loss of voltage persist for such an interval that it causes the equipment to shutdown, the reapplication of the line voltage within the specified range shall cause the SSR/DMTI to resume operation in the same configuration and functional condition as it was at the time of the shutdown with no requirement for human interventation or assistance.

3.5.2.3 Nonoperating environment.- The SSR/DMTI shall meet all functional and performance requirement specified herein when returned to the conditions of 3.5.2.1 and 3.5.2.2 after exposure to the following conditions during transit and storage.

(a) Ambient temperature	-55° to +65° C
(b) Altitude	2,000 feet (609.6m) below, to 10,000 feet (3048m) above mean sea level
(c) Shock	That encountered in a square landing from a free fall of at least 6.0 inches (15.24Cm) when crated and blocked for shipment
(d) Vibration	Single frequency sine-wave vibration of 2.2 g pk between 20 and 60 Hz for 20 minutes. Refer to section 50.1.3, appendix B, MIL-STD-781.

When so required by the contract and necessary to meet these requirements, a transit case shall be provided with the equipment. In any case, the characteristics and the use of transit case shall be fully described in the SSR/DMTI equipment instruction book. The packaged equipment shall be capable of being air transported in any orientation.

3.6 Technical requirements.- The following paragraphs define the technical requirements of the SSR/DMTI modification kit and the performance of the modified radar systems as affected by the installation.

3.6.1 Receiver equipment.- Each modification kit shall have a complete rf receiver equipment for each channel as described herein. The receiver equipment shall be designed to be used in conjunction with the existing ARSR-1E, -1, or FPS-20 family of radars) transmitter, existing (ARSR-1E, -2, or FPS-20 family of radars) frontend components (consisting of passive tr, waveguide-to-coaxial transition, limiter, rf attenuator, solid-state rf amplifier, preselector filter, and solid-state double balanced mixer), and other ancillary items described herein to provide the overall system performance specified. The receiver processor equipment shall contain all other features and ancillary items required to interface with the transmitter control system and other ARSR-1E, -2, or FPS-20 family of radars functions.

3.6.2 Stable local oscillator (STALO) for FPS-20 family of radars.- Each modification kit shall contain a new STALO for each radar channel. The STALO shall generate a local oscillator signal within the frequency, power, and stability limits necessary for MTI receiver operation and for mixing with the coherent oscillator signal to produce the transmitter frequency. A meter and metering circuitry shall be provided to monitor the STALO drive signal as a maintenance check. The STALO frequency shall be controlled by a plug-in replaceable crystal.

3.5.2.3 Nonoperating environment.- The SSR/DMTI shall meet all functional and performance requirement specified herein when returned to the conditions of 3.5.2.1 and 3.5.2.2 after exposure to the following conditions during transit and storage.

(a) Ambient temperature	-55° to +65° C
(b) Altitude	2,000 feet (609.6m) below, to 10,000 feet (3048m) above mean sea level
(c) Shock	That encountered in a square landing from a free fall of at least 6.0 inches (15.24Cm) when crated and blocked for shipment
(d) Vibration	Single frequency sine-wave vibration of 2.2 g pk between 20 and 60 Hz for 20 minutes. Refer to section 50.1.3, appendix B, MIL-STD-781.

When so required by the contract and necessary to meet these requirements, a transit case shall be provided with the equipment. In any case, the characteristics and the use of transit case shall be fully described in the SSR/DMTI equipment instruction book. The packaged equipment shall be capable of being air transported in any orientation.

3.6 Technical requirements.- The following paragraphs define the technical requirements of the SSR/DMTI modification kit and the performance of the modified radar systems as affected by the installation.

3.6.1 Receiver equipment.- Each modification kit shall have a complete rf receiver equipment for each channel as described herein. The receiver equipment shall be designed to be used in conjunction with the existing ARSR-1E, -1, or FPS-20 family of radars) transmitter, existing (ARSR-1E, -2, or FPS-20 family of radars) frontend components (consisting of passive tr, waveguide-to-coaxial transition, limiter, rf attenuator, solid-state rf amplifier, preselector filter, and solid-state double balanced mixer), and other ancillary items described herein to provide the overall system performance specified. The receiver processor equipment shall contain all other features and ancillary items required to interface with the transmitter control system and other ARSR-1E, -2, or FPS-20 family of radars functions.

3.6.2 Stable local oscillator (STALO) for FPS-20 family of radars.- Each modification kit shall contain a new STALO for each radar channel. The STALO shall generate a local oscillator signal within the frequency, power, and stability limits necessary for MTI receiver operation and for mixing with the coherent oscillator signal to produce the transmitter frequency. A meter and metering circuitry shall be provided to monitor the STALO drive signal as a maintenance check. The STALO frequency shall be controlled by a plug-in replaceable crystal.

3.6.3.1 Detail common requirements.- The following requirements are applicable to the COHO for both the ARSR-1, -2, and FPS-20 family of radars:

(a) Frequency	30 mHz nominal
(b) Long-term stability	+/- 0.005 percent of output frequency per week
(c) Short-term stability	1 part in 10^8 per 1500 usec (120 nmi)
(d) Output impedance	50 ohms nominal

3.6.3.1.1 COHO Mixer ARSR-1, -2.- A COHO mixer is required for the ARSR-1, -2 series radars. It combines a transmitter sample pulse with the STALO signal and produces a coherent 30 mHz signal output. This 30 mHz coherent rf pulse is used to lock the COHO phase with the magnetron.

3.6.3.1.2 COHO ARSR-1, -2.- Each modification kit shall contain a new COHO for each radar channel. The COHO shall be an injection-locked LC oscillator, with a nominal frequency of 30 mHz. The limitation imposed by the COHO shall not limit the system improvement factor to less than 40 dB.

3.6.3.1.3 Timing Generator Outputs ARSR-1, -2.- A circuit shall be provided which detects the transmitted output and synchronizes the range clock to the transmitted pulse. The timing jitter associated with this circuit shall not limit the MTI improvement factor to less than 40 dB.

The timing generator shall have multiple, isolated outputs with the stability and power level required to properly interface with the MTI phase detectors, synchronizer, DMTI clock, STC clock, CD-2 clock (specification FAA-E-2679) and the transmitter requirements as specified in ORder 6340.6 or Order 6340.8 as appropriate. An isolated spare output shall be provided for future use and shall be properly terminated.

3.6.3.2 Additional requirements applicable to FPS-20 family of radars.- The COHO for the FPS-20 family of radars shall include a modulator to provide a pulse COHO output, in addition to the cW outputs, with the following specification. The transmitter frequency shall be derived from STALO and COHO frequencies.

(a) Pulse width	9 us +/- 0.5 us
(b) Output level	4 watts peak
(c) cW leakage	-80 dB
(d) Rise time	less than 0.1/us

The COHO shall be crystal controlled, directly or indirectly.

3.6.3.2.1 COHO output.- The COHO shall have multiple, isolated cW outputs with stability and power level required to properly interface with the MTI phase detectors, synchronizer, and test signal generators. An isolated spare output shall be provided for future use and shall be properly terminated.

3.6.4 RF signal generator (rfg).- Each modification kit shall include an rf signal generator system consisting of an IF test signal generator and a rf test signal generator for each channel. The paragraph below describes the requirements for these generators.

3.6.4.1 IF test signal generator.- The IF test signal generator shall be used for checking and aligning all receivers and the MTI canceller system. Requrements for the IF test signal generator are as follows:

3.6.4.1.1 Signal source.- The IF signal generator shall be capable of operating with the output signal of the COHO or from a built-in 30 mHz source. The frequency of the internal source shall be slightly offset from the frequency of the COHO so as to produce a triangular waveshape signal on the output of the MTI receiver phase detector.

3.6.4.1.2 Modulators.- Two separate pulse modulators shall be provided; one for fixed target and one for moving target generation. Each modulator shall include a phase shift control such that the phase of the modulator shall be continuously variable between -90 degrees and +90 degrees or greater. The modulator for the moving target shall also include a phase shift control such that the phase of the modulator shall be continously variable between 0 and 180 degrees and, in addition, the phase shall change by 90 and 180 degrees on consecutive PRT's. The pulse width of the fixed target shall be adjustable from 2 to 20 usec. The pulse width of the moving target shall be adjustable from 1 to 10 usec. The range of the targets shall be adjustable from 0 miles to maximum range and shall be sychronous with the MTI range bin clock. The mW leakage (output with no modulation) of the modulators shall be a least 60 dB below the pulse modulated level.

3.6.4.1.3 Output level.- The output level shall be sufficient as to cause at least 10 dB of limiting in any SSR/DMTI IF amplifier when fed into it's input. The output attenuator dials shall read directly into dB. Two variable attenuators connected in tandem shall be provided: one having 110 dB range with at least 10 dB steps and one that is variable from 0 to 10 dB in increments not exceeding 1.0 dB. The accuracy of the output level shall be +/- 0.75 dB of the attenuator dial readings for all settings at the input of the IF amplifier. An internal calibrated output level measurement and adjustment capability shall be provided. Separate attenuators shall be provided for the moving and fixed targets. The output of the attenuators shall be combined into a single output. This signal will be connected to the input of the IF preamplifier of the rf front end.

3.6.4.1.4 External trigger.- Provision shall be provided for triggering the pulse modulators switch selectable from either the internal pretrigger, test trigger from the CD-2 test trigger or from an external jack located on the front panel of the signal generator. Trigger characteristics shall be obtained from appropriate specifications or equipment instruction books.

3.6.4.2 RF test signal generator.- Each modification kit shall include one rf signal generator for each radar channel to facilitate calibration and testing the receiver.

3.6.4.2.1 Signal source.- The rf signal generator output shall be derived from the COHO and STALO signals and shall be appropriately leveled, modulated, filtered, and attenuated to provide a test signal at the transmitter frequency.

3.6.4.2.2 Modulator.- The modulator shall provide an adjustable pulse width output (1 us to 10 us) and continuously variable in range from 0 miles to beyond end of range in increments of 1/2 mile or less and shall be synchronous with the closest preceding MTI range bin. The variable test target shall not interfere with the fixed test target.

3.6.4.2.3 Output level.- The maximum power output shall be at least -10bBm. A step attenuator with at least 10 steps of 10 dB and a variable attenuator of 10 dB, variable in steps not greater than 1.0 dB, shall be connected in tandem. The attenuator shall read directly in dB. The output level indicator shall be calibrated to read in the dB power level existing at the output of the directional couplers feeding the waveguide to coax adapter connected to the rf receiver front end. The accuracy of the output shall be within 0.75 dB of the dial setting for the range of -100 to -116 dBm and the tolerance of the signal generator output over the range of -10 to -100 dBm shall be +/- 1 dB or 2 percent of the output reading whichever is greater.

3.6.4.2.4 External trigger.- Provision shall be made for triggering the pulse modulators from either the internal pretrigger, test trigger from the CD-2 test trigger or from an external jack located on the front panel of the signal generator. The external trigger circuitry shall be capable of operation with trigger levels of 2.5 to 70 volts.

3.6.5 Receiver rf front end description.- The Government will have installed in each channel of the ARSR-1, -2, or FPS-20 family of radars a receiver protective device, waveguide to coaxial transition, limiter, solid-state pin diode microwave attenuator, solid-state rf amplifier, tuneable filter, and mixer. The contractor shall provide an IF preamplifier. The preamplifier shall have at least one spare isolated output in addition to other requirements. The following describes the overall specification for the rf receiver front end.

(a) Type	Single conversion superheterodyne
(b) Operating frequency	1250-1350 mHz
(c) IF frequency	30 mHz nominal
(d) RF bandwidth	Not greater than 12 mHz at 3dB point measured at output of mixer and not less than 26 mHz at 40dB down
(e) Image rejection	60 dB minimum
(f) Off frequency rejection	60 dB at +/- 60 mHz 36 dB at +/- 30 mHz
(g) Noise figure at receiver signal mixer output	
ARSR-1, -2	4.0 dB typical
FPS-20 family of radars	4.0 dB typical
(h) Dynamic Range	70 dB min at output of receiver signal mixer

3.6.4.2.1 Signal source.- The rf signal generator output shall be derived from the COHO and STALO signals and shall be appropriately leveled, modulated, filtered, and attenuated to provide a test signal at the transmitter frequency.

3.6.4.2.2 Modulator.- The modulator shall provide an adjustable pulse width output (1 us to 10 us) and continuously variable in range from 0 miles to beyond end of range in increments of 1/2 mile or less and shall be synchronous with the closest preceding MTI range bin. The variable test target shall not interfere with the fixed test target.

3.6.4.2.3 Output level.- The maximum power output shall be at least -10bBm. A step attenuator with at least 10 steps of 10 dB and a variable attenuator of 10 dB, variable in steps not greater than 1.0 dB, shall be connected in tandem. The attenuator shall read directly in dB. The output level indicator shall be calibrated to read in the dB power level existing at the output of the directional couplers feeding the waveguide to coax adapter connected to the rf receiver front end. The accuracy of the output shall be within 0.75 dB of the dial setting for the range of -100 to -116 dBm and the tolerance of the signal generator output over the range of -10 to -100 dBm shall be +/- 1 dB or 2 percent of the output reading whichever is greater.

3.6.4.2.4 External trigger.- Provision shall be made for triggering the pulse modulators from either the internal pretrigger, test trigger from the CD-2 test trigger or from an external jack located on the front panel of the signal generator. The external trigger circuitry shall be capable of operation with trigger levels of 2.5 to 70 volts.

3.6.5 Receiver rf front end description.- The Government will have installed in each channel of the ARSR-1, -2, or FPS-20 family of radars a receiver protective device, waveguide to coaxial transition, limiter, solid-state pin diode microwave attenuator, solid-state rf amplifier, tuneable filter, and mixer. The contractor shall provide an IF preamplifier. The preamplifier shall have at least one spare isolated output in addition to other requirements. The following describes the overall specification for the rf receiver front end.

(a) Type	Single conversion superheterodyne
(b) Operating frequency	1250-1350 mHz
(c) IF frequency	30 mHz nominal
(d) RF bandwidth	Not greater than 12 mHz at 3dB point measured at output of mixer and not less than 26 mHz at 40dB down
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(g) Noise figure at receiver signal mixer output	
ARSR-1, -2	4.0 dB typical
FPS-20 family of radars	4.0 dB typical
(h) Dynamic Range	70 dB min at output of receiver signal mixer

3.6.5.8 Receiver IF preamplifier.- Each modification kit shall contain a receiver IF preamplifier for each radar channel. A preamplifier shall be installed in the receiver path following the signal mixer. The preamplifier shall be matched to the signal mixer output. The preamplifier shall be designed and located such that the combination of input cable losses and preamplifier noise figure do not degrade overall system noise figure by 0.25 dB. The IF preamplifier shall accept the nominal 30 mHz output from the signal mixer and provide the necessary gain control capability, amplification, dynamic range, and bandpass characteristics to drive the subsequent circuits.

The IF preamplifier shall not have less than one spare isolated low impedance output; unused outputs shall be properly terminated. Provision shall be made for manual gain control of the preamplifier.

The bandpass of the preamplifier shall be at least 10 mHz at the 3 dB points. The dynamic range of the preamplifier shall be at least 70 dB at the 1 dB compression point and shall not occur before saturation is reached in the rf amplifier. A separate input shall be provided on the IF preamplifier ahead of the gain controlled stages for injecting IF test signals from the RFG. This input shall be isolated from the receiver signal input.

3.6.6 Receiver sensitivity (MDS).- As a minimum, the various receivers shall have the MDS sensitivities specified below. The MDS of the receivers shall be measured in accordance with the procedure of paragraph 3.6.6.1. The sensitivity requirements apply to all receivers. In every case, the output line video shall be utilizied for this measurement.

	Log (log)	MTI (I&Q log)
ARSR-1, -2	-110 dBm	-107 dBm
FPS-20 (3 usec)	-112 dBm	-109 dBm
FPS-20 (6 usec)	-115 dBm	-112 dBm

3.6.6.1 Minimum discernible signal (MDS) measurement.- Procedures:

(a) Inject a calibrated 2 microsecond rf test signal for ARSR-1, -2 series radar (HP-614A or equivalent) into the directional coupler on the antenna side of the receiver protector. (Use 3 us for ARSR-60 at Trevose and 6 us for FPS-20 family of radars). Also refer to paragraph 80, FAA Order 6340.8 for the ARSR-1, -2 series radar, paragraph 155, FAA Order 6340.6 for the FPS-20 Family of Radars and paragraphs 171 and 172, FAA Order 6340.19 for the ARSR-60 Family of Radars.

(b) Display the appropriate line video on an oscilloscope. The oscilloscope sweep rate shall be 10 microsecond per cm recurring at the radar PRF. Adjust the oscilloscope for a relatively high intensity trace with good focus.

3.6.5.8 Receiver IF preamplifier.- Each modification kit shall contain a receiver IF preamplifier for each radar channel. A preamplifier shall be installed in the receiver path following the signal mixer. The preamplifier shall be matched to the signal mixer output. The preamplifier shall be designed and located such that the combination of input cable losses and preamplifier noise figure do not degrade overall system noise figure by 0.25 dB. The IF preamplifier shall accept the nominal 30 mHz output from the signal mixer and provide the necessary gain control capability, amplification, dynamic range, and bandpass characteristics to drive the subsequent circuits.

The IF preamplifier shall not have less than one spare isolated low impedance output; unused outputs shall be properly terminated. Provision shall be made for manual gain control of the preamplifier.

The bandpass of the preamplifier shall be at least 10 mHz at the 3 dB points. The dynamic range of the preamplifier shall be at least 70 dB at the 1 dB compression point and shall not occur before saturation is reached in the rf amplifier. A separate input shall be provided on the IF preamplifier ahead of the gain controlled stages for injecting IF test signals from the RFG. This input shall be isolated from the receiver signal input.

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	Log (log)	MTI (I&Q log)
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FPS-20 (6 usec)	-115 dBm	-112 dBm

3.6.6.1 Minimum discernible signal (MDS) measurement.- Procedures:

(a) Inject a calibrated 2 microsecond rf test signal for ARSR-1, -2 series radar (HP-614A or equivalent) into the directional coupler on the antenna side of the receiver protector. (Use 3 us for ARSR-60 at Trevose and 6 us for FPS-20 family of radars). Also refer to paragraph 80, FAA Order 6340.8 for the ARSR-1, -2 series radar, paragraph 155, FAA Order 6340.6 for the FPS-20 Family of Radars and paragraphs 171 and 172, FAA Order 6340.19 for the ARSR-60 Family of Radars.

(b) Display the appropriate line video on an oscilloscope. The oscilloscope sweep rate shall be 10 microsecond per cm recurring at the radar PRF. Adjust the oscilloscope for a relatively high intensity trace with good focus.

3.6.10.2 Not used.

3.6.10.3 Gain control.- One gain control mode, in addition to the STC curve, shall be provided with the STC generator. Provisions shall be included such that it will be possible to perform a fixed step gain reduction of 0 to 63 dB in 1 dB steps. It shall be possible to shift the STC characteristics a fixed attenuation amount by selecting an initial attenuation value from 0 to 63 dB, in 1 dB steps. Each of the individual inputs to the gain control shall have separate on/off switches. The inputs shall be directly added.

3.6.10.4 STC generator.- The STC generator shall be a digital/analog function generator. Two digital programmable curves shall be provided in the STC generator for each receiver. Each of the curves shall be capable of being individually programmed. The initial attenuation shall be selectable with attenuation decreasing from the initial setting at a programmable rate. The initial attenuation for the 0 to 1 mile range increment shall be selectable from 0 to 63 dB in steps no greater than 1 dB. In the range increment from 1 to 2 miles, the attenuation shall decrease as a function of range, but be programmed at selectable rates from a minimum of approximately R^0 to a maximum of approximately R^3. From the 2-mile range, the attenuation shall decrease as a function of range, but be programmed in range segments, at selectable rates from a minimum of approximately R^0 to a maximum of approximately R^4. A minimum of ten (10) programmable range segments shall be provided. The range capability of the STC generator shall be at least 128 miles. The STC curves shall be generated in maximum steps of 1 dB, and it shall be possible to select an STC curve with a switch. Programmed STC curve shall be stored such that reprogramming shall not be required if the STC is turned off or if primary power is interrupted as in transfer between commercial to emergency sources. Refer to page 5-20 to 5-23, Radar Handbook, M. Skolnk, McGraw-Hill, 1970, for information only, on Sensitivity Time Control (STC) characteristics.

3.6.10.4.1 STC selection.- STC-1, STC-2, STC-off shall be selectable from within the receiver cabinet.

3.6.10.4.2 Transmitter pulse suppression.- The receiver gain control circuit shall have features incorporated to suppress the receiver rf signals in each channel resulting from the outputs of the transmitter in either channel. This feature shall be effective at all times regardless of STC selection or programming. Receiver desensitization following the main transmitter pulse from the operational and the standby channel shall not extend for more than 20 microseconds to recover to within 0.5 dB of nominal insertion loss value.

3.6.10.4.3 Test capability.- A test capability shall be built into the STC generator to provide a visual indication of the initial attenuation and the slope of each programming segment. A switch shall be provided to manually step the curve through each program segment. A visual indication shall also be provided for the waveform applied to the microwave attenuator during normal operation. This indication shall be a function of attenuation in dB versus linear range in nautical miles.

3.6.11 IF distribution amplifier.- IF distribution amplifiers shall be provided to match receiver inputs. The IF distribution amplifier shall accept the received signals that have been converted to an intermediate frequency of 30 mHz. It shall provide IF signal output to the MTI and logarithmic receivers. It shall contain the required filtering, distribution IF amplifiers and two-way power dividers.

3.6.12 MTI IF receiver characteristics.- The MTI IF receiver shall be compatible with the quadrature and digital MTI operational requirements. The MTI amplifier shall accept its separate output from the IF distribution amplifier and process the nominal 30 mHz signals, and, in conjunction with the COHO, 90 degrees phase shifter and phase detectors, produce the two bipolar video signals for use in the quadrature MTI system. Provisions shall be included to balance the phase detector outputs for equal noise. The MTI receiver overall group delay distortion shall not exceed 10 nanoseconds.

3.6.12.1 IF bandwidth and dynamic range.- The predetection bandwidth and the dynamic range of the MTI receiver shall be optimized for ARSR-1, -2 series radar and FPS-20 series radar and shall not limit the MTI improvement factor to less than 40 dB. The output signal shall not droop more than 5 percent over a wide range of input signals and pulse durations including strongest returns.

3.6.12.2 Not Used.

3.6.12.3 Gain control.- Provisions shall be made for manual gain control of the MTI IF amplifier. This control shall provide the capability of adjusting the signal to noise ratio, as measured on the output of the phase detector, over the range of 15 dB minimum to greater than 40 dB.

3.6.12.4 Phase Detector.- The characteristics of the phase detectors shall be optimum for use with digital and quadrature MTI System. Provision shall be included in the MTI receiver to balance for equal noise from the phase detectors. Coherent bipolar video shall not unbalance with the MTI IF gain control and limit level adjustments. No objectionable IF saturating characteristics shall exist to produce dead areas following strong clutter returns.

Quadrature video detectors shall be provided in each channel. The gain and phase unbalance shall be less than 1 dB and 2 degrees respectively. Provisions shall be made for filtering spurious IF components and for automatic nulling of residual Direct Current (DC). The instantaneous receiver dynamic range defined between the front end receiver noise level and the 1 dB compression point shall be no less than 70 dB when measured from the input to the RF amplifier to the output of the quadrature video detector.

3.6.12.5 Low pass filter.- If necessary, the output of each phase detector shall be fed through a low pass filter with its 3 dB points at a value necessary to achieve optimum MTI performance for both weak and strong radar returns. As an alternative, the filtering may be accomplished digitally.

The bipolar output levels shall be compatible with the MTI processing input circuitry.

3.6.13 Log IF receiver.- The target detection log receiver shall accept a separate output from the IF distribution amplifier and provide the video output and other operational parameters as outlined below. The predetection bandwidth of the log receiver shall be optimized for the radar pulse width. The first time side lobe of the impulse response shall be at least 40 dB below peak output, with the output decaying monotonically thereafter. The center frequency and the bandwidth shall be constant over the required dynamic range of at least 80 dB.

The logarithmic characteristics shall be maintained at least within +/- 1 dB over the theoretical, over the 80 dB range. If a more stringent tolerance is required to meet other specific requirements, the more stringent tolerance shall be provided. This shall apply to all frequencies within the 3 dB bandwidth.

The design shall be such that noise at the input to the log IF can be adjusted so that the logarithmic characteristics can begin at any level from 15 to 25 dB below the RMS noise level. The overall group delay distortion for this receiver shall not exceed 35 nanoseconds.

3.6.13.1 Log video output.- Analog video outputs for local monitoring purposes, for the CD-2, RRWDS, and RMLT shall be provided from the log receiver. Undesirable video characteristics such as noise, humps, ringing, baseline shift shall not exceed 1 percent of the video amplitude. Under no conditions shall signals, noise, or transients exceed 0.04 volts below the baseline.

3.6.13.2 Video alignment.- Circuitry shall be provided to align the log video with the log video of the opposite channel during stagger or nonstagger operation. The jitter due to realignment shall not exceed 100 nanoseconds. Compatible aligned video outputs shall be provided for local monitoring, CD-2, RRWDS, and RMLT within the radar channel.

3.6.13.3 Log video selector.- The log video will be the signal ordinarily utilized in nonclutter areas. The MTI video will be used in the clutter areas. Log video and MTI video shall be available at all times for selection by the CD-2.

3.6.14 Power supplies.- The receiver processor cabinet shall contain the power supplies for all circuitry contained within the cabinet. Power supply metering circuits shall be provided for all power supplies in the receiver cabinet. The power supplies shall be in accordance with the power supply requirements stated in paragraph 3.6.27.1.2.

3.6.15 DMTI processor.- The digital moving target indicator (DMTI) processor will be used in conjunction with the antenna, transmitter, receiver, and other ancillary items described elsewhere herein and shall provide the following major functions:

The bipolar output levels shall be compatible with the MTI processing input circuitry.

3.6.13 Log IF receiver.- The target detection log receiver shall accept a separate output from the IF distribution amplifier and provide the video output and other operational parameters as outlined below. The predetection bandwidth of the log receiver shall be optimized for the radar pulse width. The first time side lobe of the impulse response shall be at least 40 dB below peak output, with the output decaying monotonically thereafter. The center frequency and the bandwidth shall be constant over the required dynamic range of at least 80 dB.

The logarithmic characteristics shall be maintained at least within +/- 1 dB over the theoretical, over the 80 dB range. If a more stringent tolerance is required to meet other specific requirements, the more stringent tolerance shall be provided. This shall apply to all frequencies within the 3 dB bandwidth.

The design shall be such that noise at the input to the log IF can be adjusted so that the logarithmic characteristics can begin at any level from 15 to 25 dB below the RMS noise level. The overall group delay distortion for this receiver shall not exceed 35 nanoseconds.

3.6.13.1 Log video output.- Analog video outputs for local monitoring purposes, for the CD-2, RRWDS, and RMLT shall be provided from the log receiver. Undesirable video characteristics such as noise, humps, ringing, baseline shift shall not exceed 1 percent of the video amplitude. Under no conditions shall signals, noise, or transients exceed 0.04 volts below the baseline.

3.6.13.2 Video alignment.- Circuitry shall be provided to align the log video with the log video of the opposite channel during stagger or nonstagger operation. The jitter due to realignment shall not exceed 100 nanoseconds. Compatible aligned video outputs shall be provided for local monitoring, CD-2, RRWDS, and RMLT within the radar channel.

3.6.13.3 Log video selector.- The log video will be the signal ordinarily utilized in nonclutter areas. The MTI video will be used in the clutter areas. Log video and MTI video shall be available at all times for selection by the CD-2.

3.6.14 Power supplies.- The receiver processor cabinet shall contain the power supplies for all circuitry contained within the cabinet. Power supply metering circuits shall be provided for all power supplies in the receiver cabinet. The power supplies shall be in accordance with the power supply requirements stated in paragraph 3.6.27.1.2.

3.6.15 DMTI processor.- The digital moving target indicator (DMTI) processor will be used in conjunction with the antenna, transmitter, receiver, and other ancillary items described elsewhere herein and shall provide the following major functions:

3.6.15.7 Realignment.- The MTI signals shall be realigned while the information is in the digital form.

3.6.15.8 I&Q video combination.- I and Q shall be converted into a digitized logarithmic representation of the input level within +/- 0.5 dB of theoretical, prior to combination, except that if a tighter tolerance is required to meet other specified requirements, the more stringent tolerance shall be met. When the I and Q are combined, they shall be processed to form the approximate square root of I^2 plus Q^2 in increments not exceeding 1/8 nautical mile. The I and Q shall be aligned. Any approximation used in the square root combination operation shall not produce an error greater than +/- 0.5 dB from 25 dB below RMS noise level to maximum MTI output. Provision shall be provided to select the I, Q, or combined I and Q signal as the output of the DMTI.

3.6.16 DMTI Processor built-in-test (BITE) equipment.- Each DMTI processor shall contain built-in-test (BITE) equipment which enables the evaluation of the digital circuits including the identification of an individual malfunctioning replaceable CCA. The BITE shall employ test methods that enable maintenance personnel to perform the off-line, go/no-go, fault isolation tests. The BITE test and analysis procedures shall be documented in the instruction book and ready reference test instructions and test indications shall be posted in the equipment. The tests shall activate the necessary clocks and timing signals and shall inject the various programmed data-stream stimuli into the processor circuits. An LED shall be activited at the faulty CCA. In addition, all faults shall have suitable front panel indication.

3.6.17 MTI cancellation measurement.- The MTI shall have sufficient stability, number of bits, and other characteristics to suppress clutter at least 40 dB as measured in accordance with the following test procedure:

(a) Adjust the MTI IF gain for a signal to noise output from the phase detector of greater than 40 dB.

(b) Apply a fixed IF test target (no phase modulation) to the input of the MTI receiver. Adjust the IF level of the target so that the target is just out of limiting.

Note the attenuator setting. While viewing the output of the canceller adjust the phase of the fixed target for maximum target residue.

(c) Apply phase modulation (0/90 degree on alternate pulses) to the test target. Adjust the test target attenuator until the residue of the moving target is equal to the residue of the fixed target noted in step (b) above. Readjust target control as necessary for peak output of the cancellor. The difference between the attenuator settings of step (b) and step (c) shall be greater than 40 dB.

3.6.15.7 Realignment.- The MTI signals shall be realigned while the information is in the digital form.

3.6.15.8 I&Q video combination.- I and Q shall be converted into a digitized logarithmic representation of the input level within +/- 0.5 dB of theoretical, prior to combination, except that if a tighter tolerance is required to meet other specified requirements, the more stringent tolerance shall be met. When the I and Q are combined, they shall be processed to form the approximate square root of I^2 plus Q^2 in increments not exceeding 1/8 nautical mile. The I and Q shall be aligned. Any approximation used in the square root combination operation shall not produce an error greater than +/- 0.5 dB from 25 dB below RMS noise level to maximum MTI output. Provision shall be provided to select the I, Q, or combined I and Q signal as the output of the DMTI.

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(b) Apply a fixed IF test target (no phase modulation) to the input of the MTI receiver. Adjust the IF level of the target so that the target is just out of limiting.

Note the attenuator setting. While viewing the output of the canceller adjust the phase of the fixed target for maximum target residue.

(c) Apply phase modulation (0/90 degree on alternate pulses) to the test target. Adjust the test target attenuator until the residue of the moving target is equal to the residue of the fixed target noted in step (b) above. Readjust target control as necessary for peak output of the cancellor. The difference between the attenuator settings of step (b) and step (c) shall be greater than 40 dB.

(g) Using the signal generator pulse delay carefully move the pulse to this exact point. Look at the MTI video output and adjust the singal generator output until the video pulse in MTI video is equal to twice the echo box residue (uncancelled residue from the echo box should be below the 1/3 video limit level output).

(h) Read the signal generator attenuator dial.

(i) The difference between signal generator attenuator readings for the 10 dB above IF limit level and twice echo box residue while the signal generator video is superimposed on an echo box signal 10 dB above IF limit level is the subclutter visibility.

(j) The SCV measured by the above method shall be 30 dB or better.

3.6.19.2 Test pulse/clutter method.-

(a) The MTI System is to be aligned and adjusted for optimum performance for an antenna rotation of 6 RPM for ARSR-1, -2 series radar or at 5 RPM for the FPS-20 family radar.

(b) Adjust the MTI IF gain so that the A/D convertor is quantizing noise for good Constant False Alarm Rate (CFAR) operation, adjust the MTI limit level and the MTI video gain following cancellation for normal operation. Uncancelled residue caused by clutter fluctations and moving targets are to be ignored

(c) Solid clutter areas on the PPI shall be examined by viewing log video on an oscilloscope. The selected clutter must be a point source target strong enough to limit in the MTI IF amplifier by 10 dB or more. A phase shifter shall be installed in the COHO path to change the phase of the target at least 180 degrees on the phase detector curve.

(d) Insert an IF test pulse into the receiver preamplifier with a pulse duration of two microseconds or greater. The phase of the test pulse relative to the COHO shall change approximately 0/90 degree between pulses.

(e) Adjust the IF test pulse so that it is equal in amplitude to the selected block or clutter. Note that attenuator setting.

(f) Move the IF test pulse in range until it is completely superimposed on the selected block of clutter.

(g) With the antenna rotating, observe the PPI presentation and attenuate the test pulse until the ring on the PPI is barely perceptiable over the selected clutter block, with the phase shifter adjusted to produce maximum residue.

(g) Using the signal generator pulse delay carefully move the pulse to this exact point. Look at the MTI video output and adjust the singal generator output until the video pulse in MTI video is equal to twice the echo box residue (uncancelled residue from the echo box should be below the 1/3 video limit level output).

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(d) Insert an IF test pulse into the receiver preamplifier with a pulse duration of two microseconds or greater. The phase of the test pulse relative to the COHO shall change approximately 0/90 degree between pulses.

(e) Adjust the IF test pulse so that it is equal in amplitude to the selected block or clutter. Note that attenuator setting.

(f) Move the IF test pulse in range until it is completely superimposed on the selected block of clutter.

(g) With the antenna rotating, observe the PPI presentation and attenuate the test pulse until the ring on the PPI is barely perceptiable over the selected clutter block, with the phase shifter adjusted to produce maximum residue.

approval the stagger ratios over the range of 280 to 370 pulses per second with the system design data for this requirement. It shall be possible to operate the system on any one of the individual stagger periods by front panel switch(es). There shall be no detectable displayed interference in any of the 0 nm or 200 nm video presentation due to any of the system triggers. The average PRF of the radar shall be adjustable over the range of 280 to approximtely 370 pulses per second during the stagger operation. The average period shall be variable in approximately twenty (20) microsecond steps by solder jumpers or equivalent implementation.

3.6.21.1.2 FPS-20 family stagger operation transmitter modifications.- Each modification kit for the FPS-20 family of radars shall contain appropriate FPS-20 transmitter modification for each channel to ensure proper stagger operation and ensure satisfactory MTI performance. These modifications shall include but not be limited to installation of charging diodes and replacement charging chokes in the FPS-20 family high voltage modulator, modulator driver and IPA modulator.

3.6.21.2 Master/slave operation.- Either channel synchronizer shall be capable of supplying synchronizing triggers to both channels. The controls, ancillary devices, and circuitry shall be configured such that when one channel synchronizer fails, the synchronizer with the operating channel shall automatically become master. The first channel to have a fully operational synchronizer shall become the master channel for sychronization. Once both channels are fully operational, either channel may be selected as a master by a front panel switch on the master control panel. Indications shall be provided to determine which channel is master.

3.6.21.3 Realignment triggers.- A start-of sequence trigger shall be generated at the beginning of each stagger sequence. This trigger shall be at least 15 volts across 75 ohms using a BNC connector and in addition to any internal requirement, the trigger shall be available on the exterior of the cabinet for use in external equipment.

3.6.21.4 Aligned pretriggers.- The synchronizer shall generate aligned pretriggers which occur 100 microseconds ahead of aligned zero range time. These pretriggers shall be provided as necessary for utilization within each channel. An isolated TTL level output shall be provided in the switching and distribution circuitry using a BNC connector.

3.6.21.5 DMTI clock pulses.- The DMTI clock pulses shall be generated within the synchronizer and shall be compatible with the DMTI range bin size and the I&Q stagger requirement.

3.6.21.6 Range clock pulses.- The range clock pulses shall occur at 1/8 nautical mile intervals. The range clock pulses shall be used for the IF signal generator range adjustment, RF signal generator range information, and other applications. A spare isolated output with an output level of +5.0 volts minimum across 75 ohms shall be provided using a BNC connector.

3.6-21.7 Aligned zero time triggers.- The synchronizer shall generate a zero range (time) trigger which is aligned with zero range video output.

3.6.22 Signal processing and distribution.- The analog output videos, triggers, clocks, and gates shall be standardized throughout the system to the maximum extent possible. All signals shall be suitable for distribution over cables with nominal impedance of 75 ohms. The design of the analog video amplification processing and distribution circuitry and preceding circuitry shall be such that noise, humps, ringing, baseline shifts, and overshoots shall not exceed 5 percent of the peak signal level (with the video signal adjusted over the range of 1 to 4 volts). The droop of the video outputs shall not exceed 15 percent with a 300 microsecond RF pulse applied to the receiver input with sufficient amplitude to produce 4 volts of video output. The DC baseline level at the video outputs shall not exceed +/- 0.05 volts. All unused video amplifier outputs shall be properly terminated. Termination resistors may be mounted on video amplifer for termination of unused video outputs; wire jumpers shall be used on the printed circuit board connector to connect this termination to the unused output. Negative going signals in excess of 0.1 volts shall not be present to the output under normal operating conditions.

The search videos shall consist of two real-time analog video serial data streams and two real-time, ten-bit digital word streams representing the amplitude of the two videos. One video will come from the mti receiver and the other from the logarithmic receiver. The analog video shall be provided for local monitoring purposes, for the CD-2, RRWDS, and RMLT. The digital video is for future use by the CD-2.

The logarithmic video shall use a curve approximately 15 dB per volt with up to 80 dB of dynamic range extending from approximately 0.3 volts into the noise to 4.0 volts or more. MTI and logarithmic videos amplifiers shall be capable of driving up to 350 feet of cable terminated in 75 ohms and producing video described below at the output end of the cable. The new video outputs shall be cabled and terminated to each required location in the radar equipment building. The videos shall have maximum dynamic range and have as little limiting as is possible. The videos shall be synchronized in time with the radar pretrigger. The nominal characteristics of the analog videos shall be as follows:

	Amplitude	Noise	Baseline	SNR
(a) MTI log	+4.0V	+0.5V	0.0V	8:1
(b) Log	+4.0V	+0.5V	0.0V	8:1

An analog-to-digital (A/D) converter shall provide two independent samples for the 2 and 3 microsecond radar and four independent samples for the 6 microsecond radar of the logarithmic receiver detector output and generate a digital word containing at least eleven (11) bits. The digital words of video data from the logarithmic and mti receivers shall be clocked into the CD-2 by a "sample valid" signal from the radar. Appropriate buffers and line drivers shall be provided. The Least Significant Bit (LSB) of the word will represent approximately 8 mV. The videos will generally be the digital equivalent of the analog videos described above. They will be provided on a balanced-current, twisted pair transmission lines which are driven by type 75109 (or equivalent) integrated circuit drivers.

3.6.22.1 Video amplifiers.- The digital processed video shall be converted to analog by means of digital-to-analog (D/A) converters and buffer amplifiers suitable for driving analog output video circuits. The video amplifiers used for analog videos shall have high impedance inputs and each shall have two identical outputs. The outputs shall be driven by a common set of controls. The controls shall include gain, limit, DC offset, and other controls as required. The outputs shall be continuously adjustable over the range from 1 to 4 volts as a minimum. Short circuit protection shall be provided for each video output such that any termination from an open to a continuous short will not damage circuit components, blow any fuse, or have discernible effect on any other video output. No more than four video amplifiers shall be combined on any one plug-in printed circuit board. Test points for the input and output video signals shall be provided on the front of each amplifier. The card rack slots for the video amplifiers shall be prominently labeled as the video amplifier function. Each amplifier shall have an inhibit gate input, a 5 volt input shall inhibit all outputs from the amplifier. A switch and a power source shall be provided to implement this function.

3.6.22.2 Trigger isolation amplifiers.- The trigger distribution amplifier shall have the same characteristics as the analog video amplifiers except that the output shall be such that the pulses with rise times of 0.1 microseconds can be amplified to a level of 20 volts minimum and the jitter shall be less than 10 nanoseconds with respect to the input trigger.

3.6.22.3 Miscellaneous signal distribution.- The required clock and gate signals shall be switched with the master channel and distributed as appropriate.

3.6.22.4 Video realignment.- Video delays shall be provided with each modification kit to align all system video outputs for range coincidence within +/-0.2 usec at the receiver system output. The video delay printed circuit boards shall be configured such that after system delays have been refined, interchanging of any video delay cards within the system shall result in range coincidence within +/- 1.0 usec without further adjustment. Any changes to system triggers or other timing required as a result of this modification shall be accomplished by the modification kit, or if no parts are required, described such that installation personnel, may properly time the radar and associated secondary radar system at each site modified.

3.6.22.5 Receiver output selection.- Each modification kit shall contain a provision for selecting the output of either channel for distribution of the output signals to equipment such as CD-2, RMLT, RRDWS, etc. The receiver selection device shall provide for termination of the inputs from the unused channel.

3.6.22.5.1 ARSR-1E, -2 receiver selection control.- Selection of the receiver output shall be determined by the channel connected to the antenna.

3.6.22.5.2 FPS-20 family receiver selection control.- Selection of the receiver output for the FPS-20 family of radars shall be controlled as listed below:

(a) IF only simplex operation is possible; i.e., only one channel is connected to the antenna. The selected receiver shall be the channel which is connected to the antenna.

(b) When diplex operation is possible; i.e., both channels are connected to the antenna, selection of the channel to provide receiver output shall be controlled by a front panel switch.

3.6.22.6 FPS-20 family video combining and distribution.- Two operational adder/switch cards shall be provided to combine and/or channel switch the videos from the two radar channels. The adder switches shall have an output that is selected to be one of three modes: (1) simplex one, (2) simplex two, or (3) diplex as described in paragraph 3.6.24.2 herein. There shall be separate adder/switches for each of the following videos: (1) normal log and (2) MTI log. Adjustments shall be provided such that with normally operating transmitter and receiver channels, the average amplitude of noise peaks and the amplitude of limited signals at the video outputs shall remain at the same level with automatic or manual changes of receiver operational modes.

3.6.23 Maintenance test panel.- A maintenance test panel shall be provided for each channel of each kit. The panel shall consists of the test features listed in the paragraph below.

3.6.23.1 Analog video test selector.- A video test selector switch shall be incorporated on the maintenance test panel to provide a common place for monitoring the primary signal flow through the video processing circuits. As a minimum, the key points listed below shall be available through selectable switches. Two (2) identical video selectors switches shall be provided. An isolation amplifier shall be provided for each switch. The isolation amplifier shall have unity gain, high input impedance and a 75 ohms output impedance. A suitable D to A convertor shall be provided for those test points which are multibit wide digital signals. The output circuit from each amplifier shall be connected to a front panel BNC connector and shall be cabled from a rear panel connector to the maintenance PPI.

(a) Log video
  (1) Output of receiver
  (2) Output of log destagger
  (3) Video Output

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(a) Log video
  (1) Output of receiver
  (2) Output of log destagger
  (3) Video Output

RF sensing shall be provided to detect the presence of RF power from each transmitter at the antenna side of the waveguide switch. An audible alarm shall be sounded upon loss of RF power from a transmitter channel to the antenna for an approximate interval of 10 seconds. The alarm shall be audible from any point within the radar equipment room. Loss of RF power to the antenna from one channel while operating in the diplex mode shall cause atuomatic switching to any useable simplex receiver mode regardless of the receiver mode selected. In the event that a selected mode of operation fails and no other mode of operation is available, the audible alarm shall sound continuously. A test operate switch to disable or bypass each RF sensing circuit shall be provided. The audible alarm for each channel shall have a different pitch or other audible characteristics so that the faulted channel can be easily recognized. A switch to disable or bypass the audible alarm but simultaneously turn on a wall mounted red incandescant lamp shall be provided.

A logic control system shall be provided for the selection of Simplex A, Simplex B or diplex mode of operation. The selection is to be accomplished via front panel switches. When transmitters are operating in the diplex mode, either desired receiver simplex mode or the diplex mode may be selected. Additionally, the logic control system shall provide independent selection of Simplex A, Simplex B or diplex for each of the video outputs when available as indicated by the transmitter sensing circuitry. The logic system shall store in memory, the video modes selected so that if a selected mode temporarily fails, an operable mode will be temporarily selected and then upon correction of the failure, the previous selection will be restored automatically.

Visual indications shall be provided for each of the video independent select switches for that video. A fault indicator (red) shall be provided for each video independent select switch. The fault indicator shall illuminate if the selected mode has faulted and shall remain lit even through an operable mode is automatically selected. A transmitter monitor indicator shall be provided to indicate whether the associated RF sensing circuit for the transmitter power monitoring is in the test or operate mode. A lamp test circuit shall be provided to check the operation of all indicator lamps.

3.6.24.3 Operation monitor and control panel.- The operation monitor and control panel shall provide as a minimum the following controls and indicators:

(a) Controls:

(1) STC select	(OFF 1,2)
(2) RF attenuation select	(OFF, ON)
(3) MTI feedback select	(OFF, 25dB, 40 dB)
(4) Stagger sequence select	(OFF, 1, 2, 3, 4)
(5) Synchronizer	(NORMAL/TEST)
(6) Lamp test	Momentary switch

(b) Indicators:

(1) Channel status	(OPER/STBY/TEST)
(2) Synchronizer status	(MASTER/SLAVE/TEST)

RF sensing shall be provided to detect the presence of RF power from each transmitter at the antenna side of the waveguide switch. An audible alarm shall be sounded upon loss of RF power from a transmitter channel to the antenna for an approximate interval of 10 seconds. The alarm shall be audible from any point within the radar equipment room. Loss of RF power to the antenna from one channel while operating in the diplex mode shall cause atuomatic switching to any useable simplex receiver mode regardless of the receiver mode selected. In the event that a selected mode of operation fails and no other mode of operation is available, the audible alarm shall sound continuously. A test operate switch to disable or bypass each RF sensing circuit shall be provided. The audible alarm for each channel shall have a different pitch or other audible characteristics so that the faulted channel can be easily recognized. A switch to disable or bypass the audible alarm but simultaneously turn on a wall mounted red incandescant lamp shall be provided.

A logic control system shall be provided for the selection of Simplex A, Simplex B or diplex mode of operation. The selection is to be accomplished via front panel switches. When transmitters are operating in the diplex mode, either desired receiver simplex mode or the diplex mode may be selected. Additionally, the logic control system shall provide independent selection of Simplex A, Simplex B or diplex for each of the video outputs when available as indicated by the transmitter sensing circuitry. The logic system shall store in memory, the video modes selected so that if a selected mode temporarily fails, an operable mode will be temporarily selected and then upon correction of the failure, the previous selection will be restored automatically.

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(4) Stagger sequence select	(OFF, 1, 2, 3, 4)
(5) Synchronizer	(NORMAL/TEST)
(6) Lamp test	Momentary switch

(b) Indicators:

(1) Channel status	(OPER/STBY/TEST)
(2) Synchronizer status	(MASTER/SLAVE/TEST)

3.6.26 ACP/ARP processor for FPS-20 family.- Each modification kit shall include a circuit card which will convert the fine grain data from the FPS-20 family of radars antenna pedestal to ACP and ARP pulses for the CD-2. The circuit card shall function with either the TD-140 or the SG-244 fine grain data generators. Strapping shall be provided for selecting the type of input.

3.6.26.1 Input signal characteristics.- The following describes the input characteristics of the ACP and ARP signals.

(a) Amplitude:	
(b) Termination	
(TD-140):	600 ohms balanced line.
(SG-244):	600 ohms single-ended
(c) Type of signals:	sine wave
(d) Frequency	
ACP:	4096 per antenna revolution
ARP:	1 per antenna revolution

3.6.26.2 Output requirements.- The following describes the output requirements for the ACP and ARP pulses:

(a) Amplitude	+ 15 volt nominal
(b) Baseline	0.0 volt +/- 0.5 volt
(c) Pulse width	1 us min, 50 usec maximum
(d) Rise time	0.1 us nominal, 0.3 us maximum
(e) Fall time	0.2 us nominal, 0.5 us maximum
(f) Impedance	75 ohms

3.6.27 General design requirements.- The SSR/DMTI modification kit shall be designed and constructed to comply with the electrical and mechanical design requirements specified in the following paragraphs. All modules and assemblies of a given type shall be identical and interchanageable.

3.6.27.1 Electrical design requirements.- The electrical design of the SSR/DMTI shall have its own power supplies and associated controls for the ac power lines. A master SSR/DMTI power control shall be provided for each channel. All controls shall meet the requirements of FAA-G-2100, paragraphs 3.3.2.1.1, 3.3.2.1.2, 3.3.2.1.3, and 3.3.2.1.5. The power on-off controls shall be circuit breakers meeting the requirements of 3.5.4 of FAA-G-2100; fuses shall not be allowed as protective devices for any module. A tripped or manually turned-off breaker on any module shall initiate a conspicuous display of that condition. It shall not be possible for a module to be without power, without an indication of that condition appearing on a panel and initiating an audible alarm, if it is enabled. The load between phases shall be balanced to within 10 percent when both SSR/DMTI channels are powered on.

3.6.27.1.2 Power supplies.- Each SSR/DMTI channel shall contain all of the power supplies necessary to operate its internal circuitry and meet the requirements established elsewhere herein. All power supplies shall be self-protecting such that a continuous short on the output will not damage any wiring or components and that the output voltage will return to normal promptly upon removal of the short. This protection shall be accomplished without the use of fuses, circuit breakers or relays and shall provide a indication on the front panel during an overload condition. The SSR/DMTI shall be designed to minimize the number of types of power supplies required in the SSR/DMTI. In the event of a partial failure of a power supply, the affected and unaffected units shall automatically remove any remaining companion voltages from components which could be damaged by the loss or reduction of a portion of their normal operating voltages. Partial and full failures shall be reported as required above. Each module's power supplies shall be independently controlled and protected in accordance with paragraph 3.3.2.4.4 of FAA-G-2100. The electrical efficiency of each power supply unit, defined as output power divided by input power, shall be 70 percent or less in the as-delivered equipment. All power supplies shall meet or exceed the isolation requirements of paragraph 3.3.2.1.7 of FAA-G-2100. Transformers contained within unit especially designed for use in the SSR/DMTI shall comply with the requirements of paragraph 3.5.35 of FAA-G-2100.

3.6.27.1.3 Regulation.- All power supplies shall be electronically regulated using independent and separate solid-state voltage reference devices for each regulated output voltage. The regulation of one voltage shall not require another output voltage for a bias or a reference, even if multiple output voltages are provided from a single power supply unit. The regulation of each output voltage shall be sufficient to provide the specified equipment performance in any allowable service 'condition, including loading the supply to maximum load. Each supply voltage for a digital logic load (+5 Vdc) shall not vary more than +0.5 percent as measured with its load varying from 30 percent less than, to 50 percent greater than the normal load, and the supply line voltage varying between the service limits. Voltages for other load type shall be regulated such that under these same line voltage conditions they remain within tolerances set in accordance with good engineering practice.

3.6.27.1.4 Ripple.- Ripple voltage is defined as the peak-to-peak value of any simple or complex waveform present in the output of a regulated dc power supply; power line frequency components and harmonics as well as switching transients, clock hash and other similar signals are included. Sufficient filtering and decoupling of all power supplies shall be provided such that the normal ripple voltage may double (as the result of power transients, component failures, card removal, module removal, or similar failures or maintenance actions) without any circuit or function being disabled or affected by such an increase in ripple.

3.6.27.1.2 Power supplies.- Each SSR/DMTI channel shall contain all of the power supplies necessary to operate its internal circuitry and meet the requirements established elsewhere herein. All power supplies shall be self-protecting such that a continuous short on the output will not damage any wiring or components and that the output voltage will return to normal promptly upon removal of the short. This protection shall be accomplished without the use of fuses, circuit breakers or relays and shall provide a indication on the front panel during an overload condition. The SSR/DMTI shall be designed to minimize the number of types of power supplies required in the SSR/DMTI. In the event of a partial failure of a power supply, the affected and unaffected units shall automatically remove any remaining companion voltages from components which could be damaged by the loss or reduction of a portion of their normal operating voltages. Partial and full failures shall be reported as required above. Each module's power supplies shall be independently controlled and protected in accordance with paragraph 3.3.2.4.4 of FAA-G-2100. The electrical efficiency of each power supply unit, defined as output power divided by input power, shall be 70 percent or less in the as-delivered equipment. All power supplies shall meet or exceed the isolation requirements of paragraph 3.3.2.1.7 of FAA-G-2100. Transformers contained within unit especially designed for use in the SSR/DMTI shall comply with the requirements of paragraph 3.5.35 of FAA-G-2100.

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3.6.27.5 Mechanical design requirements.- The mechanical design of the SSR/DMTI including cabinets, controls, and electronic modules and assemblies shall be as specified in the following subparagraphs.

3.6.27.5.1 Construction and packaging. The SSR/DMTI shall be construced in a modular fashion to the greatest extent possible, such that the requirements specified herein can be easily met. Except as otherwise permitted herein, the SSR/DMTI modules shall be implemented using plug-in circuits card assemblies (CCA), card bins, and power supplies in physically independent drawings, hinged panels or slides in a larger rack or cabinet. This requirement does not alter any other requirements (electromagnetic interference, maintainability, reliability, system performance, etc.) established herein. The design shall provide for good accessibility by personnel whose body dimensions fall within the 5th and the 95th percentile as specified in paragraph 5.6 of MIL-STD-1472. The accessiblity shall permit easy and convenient operation, calibration, viewing and maintenance of the equipment's panels, controls, displays, units, modules, wiring, CCAs, and components as specified by paragraph 3.3.1.1 of FAA-G-2100. Accessibility may be improved using extenders as specified in 3.6.28.2.2. Each unit and module shall be able to be removed from the equipment cabinet without requiring the partial or complete dissembly or removal of adjacent units, modules, or cabinets. The design shall provide a neat and pleasing appearance, with and without access doors in place. The design and construction of the SSR/DMTI shall be subject to acceptance by the Government.

3.6.27.5.1.1 Physical size.- The equipment specified herein shall be able to be easily istalled in buildings with 36-inch (0.9 m) wide doors and ceiling heights of 96 inches (2.4 m). The dimensions of individual cabinets shall not exceed 80 inches (2.0 m) in width, Smaller dimensions are desirable, providing that accessiblity is not degraded. These dimensions exclude handles, cable ducts and connectors, which shall add no more than 2.0 inches (5.1 cm) to these values.

3.6.27.5.1.2 Cabinets.- Each cabinet shall be designed for front access only, to permit location of the cabinets next to walls and other equipment. The design shall not require open spaces on the sides or rear of the cabinet.

The structural strength and rigidity of the equipment units and cabinets shall be such that handling during loading shipping, unloading and positioning or the prolonged extension of drawers or slides does not result in any permanent set or deformation sufficient to impair the operability or appearance of the cabinets and mechanical parts thereof. Specifically, ease of maintenance, movability of modules or access doors and the integrity of ventilation equipment shall not be impaired. These requirements shall not be dependent on any structural strength or rigidity provided by access doors or removable modules or drawers.

Cabinets and equipment shall not exceed a concentrated floor loading of 700 pounds per square foot (3400 kg/m^2) measured on a 2.5 inch (6.4 cm) diameter circle. The distributed floor load shall be less than 250 pounds per square foot (1200 kg/m^2). Adjustable leveling pads that accommodate floors with variations of up to 0.5 inch (1.2 cm) from level over the cabinet floor areas shall be provided at the bases of the cabinets. The cabinets shall be designed such that it is not necessary to fasten or bolt them to the floor to prevent tipping when the modules are removed or fully extended or both. All access doors shall be mounted using slip pin hinges so that the doors can be easily removed from the cabinets. The opening of an access door and extending of a module shall not interfere with similar operations on adjacent modules. Access to all parts of an extended module shall be possible without undue contortion by maintenance personnel or their exposure to hazardous voltages or mechanical devices. When cabinet lifting points, such as hooks or rings, are installed for convenience in handling, such devices shall be removed by the contractor after installation and replaced with suitably finished cap bolts. Blank panels shall be provided for any unused module space.

3.6.27.5.1.3 Modules.- Each module shall be separately hung and adequately braced, shall weigh 50 pounds (23 kg) or less and shall be able to be removed and replaced by one unassisted technician. The module's power supplies may be separable from the card case when necessary to meet these requirements. The modules with front panel controls or indicators shall contain a minimum of 10 percent spare front-panel space for future additions and modifications. All modules shall be mounted on slides or drawers which, when fully extended, can pivot up to 90 degrees if required to provide the necessary access to the rear of the module and the wiring, connectors, and similar items in the interior of the cabinet. Handles shall be provided to facilitate these operations. CCA's shall be mounted in an isolated card bin, and mated with a mother board or backplane. The wiring side of the backplane shall be accessible for modification or troubleshooting without any disassembly of the module. In the event that swing-out slides are used, their design shall prevent any part of the backplane from coming within 0.5 inches (1.2 cm) of any fixed cabinet part. The backplanes shall have removable protective covers that can be removed without tools by maintenance personnel.

All active components and those passive components with appreciable contributions to the failure rate of a SSR/DMTI channel shall be mounted on the modules to permit accessibility. Cabling and ventilation components shall be mounted in the cabinet, providing that no removals are necessary to gain access to individual modules. Spot welding may be used in the manufacture and assembly of the card bins when it is not detrimental to the operation, maintenance or service life requirements herein.

Plug-in CGA's and other plut-in assemblies, such as converters, power supplies and similar items, shall be mounted side-by-side, bookcase style in the card bin. Each card location shall be provided with full length guide

Cabinets and equipment shall not exceed a concentrated floor loading of 700 pounds per square foot (3400 kg/m^2) measured on a 2.5 inch (6.4 cm) diameter circle. The distributed floor load shall be less than 250 pounds per square foot (1200 kg/m^2). Adjustable leveling pads that accommodate floors with variations of up to 0.5 inch (1.2 cm) from level over the cabinet floor areas shall be provided at the bases of the cabinets. The cabinets shall be designed such that it is not necessary to fasten or bolt them to the floor to prevent tipping when the modules are removed or fully extended or both. All access doors shall be mounted using slip pin hinges so that the doors can be easily removed from the cabinets. The opening of an access door and extending of a module shall not interfere with similar operations on adjacent modules. Access to all parts of an extended module shall be possible without undue contortion by maintenance personnel or their exposure to hazardous voltages or mechanical devices. When cabinet lifting points, such as hooks or rings, are installed for convenience in handling, such devices shall be removed by the contractor after installation and replaced with suitably finished cap bolts. Blank panels shall be provided for any unused module space.

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All active components and those passive components with appreciable contributions to the failure rate of a SSR/DMTI channel shall be mounted on the modules to permit accessibility. Cabling and ventilation components shall be mounted in the cabinet, providing that no removals are necessary to gain access to individual modules. Spot welding may be used in the manufacture and assembly of the card bins when it is not detrimental to the operation, maintenance or service life requirements herein.

Plug-in CGA's and other plut-in assemblies, such as converters, power supplies and similar items, shall be mounted side-by-side, bookcase style in the card bin. Each card location shall be provided with full length guide

3.6.27.5.4 Cabinet ventilation and cooling.- The thermal design of the SSR/DMTI equipment shall be in accordance with paragraph 3.3.1.9 (and associated subparagraphs) of FAA-G-2100 as amended below. No glass wool air filters shall be permitted. The thermal design shall accommodate continuous operation over the range of service conditions (3.5.2). All blowers, vents, and related cooling equipment necessary for effective ventilation and cooling of the equipment shall be provided. Each cabinet requiring forced ventilation shall contain its own blower system. The design shall be such that with any or all access doors open and any or all modules extended or removed, the equipment shall not develop hot spots exceeding 55 degrees Celsius during an 8-hour period when the ambient temperature is +30 degrees Celsius.

The air intakes shall be near the floor and their associated filters shall be accessible without opening any access doors. The exhaust outlets shall be at the top of the cabinet and shall prevent foreign objects from entering the cabinet through the exhaust opening. Individual module ventilation equipment may also be used if necessary to meet these requirements.

Motors shall be reliable, continuous-duty units with good accessibility for maintenance and testing. The motor speed shall not exceed 1750 RPM. The bearings shall be roller or ball bearings or equivalent. The impellers shall be dynamically balanced. Each motor shall be protected as required by FAA-G-2100, paragraph 3.5.21, except that no fuses or multiphase motors shall be permitted.

3.6.27.5.5 Finishes.- SSR/DMTI equipment shall be finished as required by paragraph 3.7.7, and all applicable subparagraphs of FAA-G-2100. In no instance, shall a finish interfere with the grounding, electromagnetic interference, performance, or mechanical operation of any portion of SSR/DMTI. The cabinet exteriors shall be finished with a color that blends with the ARSR-1E, -2 family or FPS-20 family, as appropriate. Color shall have a smooth, lusterless texture and shall be selected from FED-STD-595 and selected color shall be submitted to the Contracting Officer for approval.

3.6.27.5.6 Dissimilar metals.- Dissimilar metals exhibiting an electrolytic potential difference greater than 0.4 volt when immersed in a 3 percent sodium chloride solution shall not be used in intimate contact unless protected against electrolytic corrosion in accordance with paragraph 3.6.3, FAA-G-2100.

3.6.27.5.7 Mechanical design of electronic components.- The mechanical designs and mounting of the electronic assemblies and components used in the SSR/DMTI equipment shall be as described in the following subparagraphs.

3.6.27.5.7.1 Backplane.- Using the appropriate special tools and ancillary items, the backplanes or mother boards into which the circuit card assemblies (CCA) are inserted shall be able to be rewired in the field to change the distribution of signals within a module. Standardized power distribution busses shall be established. The backplane shall be suitable for connection of test equipment.

3.6.27.5.7.2 Circuit card assemblies.- The CCA's used for digital logic integrated circuits shall incorporate dual-in-line packages wherever feasible. The individual integrated circuits (including PROM's, processors, etc.) shall be able to be removed intact and replaced by technical personnel in less than 90 seconds. A minimum of ten removal and replacement cycles at any chip location shall be able to be performed without causing failure of the CCA or degradation of the SSR/DMTI's reliability below the requirements of 3.6.30 herein.

CCA's containing discrete semi-conductors, linear integrated circuits and their supporting components shall be able to have their active devices removed and replaced in accordance with these same requirements, except that the removal-replacement time is changed to less than 5 minutes.

All CCA's shall be able to be repaired when any component thereon fails, for the full service life of the SSR/DMTI in its normal operating and maintenance environment. The maximum size of any CCA shall be 11.0 by 14.0 inches (27.9 by 35.6 cm) or less. No conformal coatings shall be permitted. The CCA's of a given type shall be mechanically and electronically interchangeable.

The minimum number of types of CCA's necessary to implement the requirements herein shall be utilized. All CCA's shall be able to be inserted and removed with power applied to the module without causing oscillations or damage to any components and without requiring removal and reapplication of power to reinitialize the operation.

3.6.27.5.7.2.1 Component mounting.- All semi-conductor and integrated circuit components shall be mounted as specified in paragraph 3.4.8 of FAA-G-2100 unless other mounting techniques (e.g., sockets) are necessary to meet other requirements herein. In the event that such deviation is necessary, the contractor shall obtain the Contracting Officer's approval by submitting the appropriate technical justification, including the changes, if any, to the calculated reliability and service life of the equipment, indicating values with and without the deviation. All electronic parts shall be attached such that each part is amendable to removal and replacement by onsite electronic technicians.

3.6.27.5.7.2.2 CCA alterability.- To enhance the ability of the circuit card assemblies in SSR/DMTI equipment to meet future requirements, all CCA's shall be able to be modified to alter their original functions, logic operations or component interconnections. In order to provide the required alterability, CCA's consisting entirely of integrated circuits and their necessary passive supporting components such as capacitors, diodes, etc., shall use discrete point-to-point wiring on the opposite side of the CCA's from the integrated circuit chips. Multilayer printed wiring or similar techniques which produce inaccessible component interconnections shall not be used for this type of CCA's.

All other types of CCA's, including all assemblies that provide interface signals to or from equipment external to the SSR/DMTI equipment, shall utilize discrete point-to-point wiring. Alternatively, printed wiring techniques in which all intercomponent connections are accessible may be used for these CCA's. Both sides of the board may be used for such printed wiring, provided that the accessibility requirement is met.

Wrapped circuit connections meeting the requirements of, 3.6.27.5.7.3 or multilayer soldered wiring may be used as discrete point-to-point wiring. Regardless of which of these two approaches is chosen, its strength, reliability, wear-resistance and modification characteristics shall be satisfactorily demonstrated to and approved by the Government before it is used in production equipment.

3.6.27.5.7.2.3 CCA baseboard.- The CCA's shall be sufficiently rigid to prevent damage to the conductive patterns during manufacture and subsequent handling during maintenance and testing.

All CCA's shall provide a convenient and positive means of removal from and insertion into the module's card bin without the use of a separate tool. Handles, finger holds or similar means may be used. The selected technique shall permit easy removal and insertion without damage or undue strain on the module frame, the components and wiring on the CCA, or the connectors on the CCA or module. The maximum insertion or extraction force for any CCA or other plug-in assembly shall be less than 10 pounds (4.5 kg).

All CCA's shall conform to all applicable paragraphs of FAA-G-2100 except that one-part connectors and baseboards meeting the requirements of paragraph 5.7.4.2 of MIL-STD-275 are permitted and that reference designations shall be as specified in 3.6.27.7 herein. The minimum spacing between uncoated traces as given in MIL-STD-275 is modified to allow separations as small as 0.010 inches (0.25 mm) for traces with relative voltage differences of no more than 30 Vdc.

3.6.27.5.7.3 Wrapped connection.- Wrapped wire connections may be utilized on backplanes and digital logic CCA's to provide the required modification ability, Wrapped connections shall meet all requirements of MIL-STD-1130 except than tin-lead plated wrapposts need not be reflowed. Wrapped connections shall meet all requirements of paragraph 3.5.30 of FAA-G-2100.

3.6.27.5.7.4 Controls.- All circuits shall be designed so that no damage can occur when the equipment is operated with any possible setting of the internal adjustments or operating controls. Protective devices shall not be activated with the activation of any operational control. There shall be not noticeable lag between the activation or adjustment of a control and the effect of the activation or adjustment. All continuous or multiposition controls shall have calibration markings to permit setting them to predetermined positions, except where it can be demonstrated to the Government that such markings are unnecessary or impracticable. Motor-driven switches and controls are prohibited.

All other types of CCA's, including all assemblies that provide interface signals to or from equipment external to the SSR/DMTI equipment, shall utilize discrete point-to-point wiring. Alternatively, printed wiring techniques in which all intercomponent connections are accessible may be used for these CCA's. Both sides of the board may be used for such printed wiring, provided that the accessibility requirement is met.

Wrapped circuit connections meeting the requirements of, 3.6.27.5.7.3 or multilayer soldered wiring may be used as discrete point-to-point wiring. Regardless of which of these two approaches is chosen, its strength, reliability, wear-resistance and modification characteristics shall be satisfactorily demonstrated to and approved by the Government before it is used in production equipment.

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3.6.27.5.7.4 Controls.- All circuits shall be designed so that no damage can occur when the equipment is operated with any possible setting of the internal adjustments or operating controls. Protective devices shall not be activated with the activation of any operational control. There shall be not noticeable lag between the activation or adjustment of a control and the effect of the activation or adjustment. All continuous or multiposition controls shall have calibration markings to permit setting them to predetermined positions, except where it can be demonstrated to the Government that such markings are unnecessary or impracticable. Motor-driven switches and controls are prohibited.

A single set of connectors shall be provided at the cabinet and module interfaces. Terminal blocks may be used for inter-cabinet cables, in which case they shall be protected with a removal plastic cover with round access holes over each terminal for screwdrivers or test probes. All internal cabling shall include provisions for testing the continuity of each conductor. Terminal blocks, where used, shall meet this requirement with the access specified above, and shall he in accordance with paragraph 3.5.34 of FAA-G-2100. Connectors, including those for ribbon and with other multiconductor cables, shall provide test points for in-circuit signal observation or injection, of shall have test points available on backplane or CCA's entry points for each conductor. All inter-module and inter-cabinet connectors shall provide for a positive and reliable connection in the presence of reasonable physical stress in the area of the connection. Spare pins (conductors) equal to at least 20 percent of those utilized, but not less than two or each type, shall be provided at each connection.

3.6.27.5.7.5.4 Module test points.- Test points shall be provided for measurement and observation of such voltages and waveforms as are needed for the checking of performance and for the maintenance of individual modules. Test points for signals requiring frequent observation, adjustment or alignment shall be provided on the front-panel of the module or other assembly. The test points for these particular signals shall be accessible without interruption of the circuit operations or the use of extender cards. All other test points shall be located on the card bin, backplane or edge connectors of CCA's as appropriate. Each test point shall be suitable for "hands-off' connection of test equipment probes and clips. The extender card (3.6.28.1.2) may provide test points to meet this requirement for CCA's. All test points shall be identified with a TP number. Those permanently connected to a signal shall have a voltage, waveform, or other descriptive title adjacent thereto, except where limited by space consideration, as on a CCA's. Power supply output voltage, internal data and address bussess, (where microprocessors are used) clocks, and input-output signals at a minimum shall be available at each modules's test points. All test points shall be isolated such that test equipment loading effects, including short circuits, do not affect the source of the test point data. The equipment shall be designed to provide access to the signals and connectors for the test equipment as may be required for maintenance, calibration, and repair.

3.6.27.5.7.5.5 Front panel indicators.- All front panel indicators, including the power on-off indicators on each module and the status and alarm panel indicators, shall be in accordance with paragraph 3.5.17 of FAA-G-2100, except for indicator color and except that light-emitting diodes or other display media meeting the requirements herein may be used.

3.6.27.5.7.5.6 Front panel controls.- The front panel controls of the SSR/DMTI shall be designed for reliable service in accordance with paragraph 3.5.5 of FAA-G-2100.

3.6.27.6 Cable entry and exit locations.- All power, signal, and ground cables connecting the SSR/DMTI cabinets to external equipments shall enter and exit the SSR/DMTI at the top of the cabinet. A single cable connection area shall be provided to minimize external duct work. Cable entrances and exits shall be designed to enable advantageous routing of cables within and between cabinets from the standpoint of accessibility, serviceability, apperance of the installed equipment and noninterference with the activities of operating and maintenance personnel. All necessary connectors shall be provided. All special tools required for able fabrication or connector removal or installation shall be provided specified in (3.6.28.2.3). The length of the external equipment cables shall be as determined by the Government for the individual site receiving the SSR/DMTI modification kit.

3.6.27.7 Reference designations and markings.- All test points, cable terminations, jacks, controls, modules, card bins, assemblies, and front panels shall be clearly and permanently marked to show their intended functions and locations, designations and titles. The reference designations shall be in accordance with section 3.8 of FAA-G-2100 except that section 3.8(b) of FAA-G-2100 shall not be used. The marking shall be accomplished as specified in section 3.9 and all applicable subsections of FAA-G-2100, except that the requirements of subsections 3.9.1 are not applicable where it is impractical, such as with automatic parts insertion devices. Line drawings in the equipment's instruction book shall be used to convey the reference designations and positions of parts on CCA's and similar assemblies. Each CCA's and any other plug-in assembly shall include identification markings which identify the basic circuit function and reference designation of the unit of which it is a part.

3.6.27.8 Mositure pockets.- The equipment shall be constructed in accordance with paragraph 3.3.3.5 of FAA-G-2100. Components shall not be mounted in the lower 4 inches (10 cm) of any cabinet.

3.6.27.9 Other requirements.- The other requirements of FAA-G-2100, paragraphs 3.4 through 3.11, which are not specifically called out elsewhere herein, shall apply.

3.6.28 Maintenance and test equipment.- The SSR/DMTI shall be designed and constructed to minimize the need for additional specialized and standard off-the-shelf equipment, tools, and fixtures for maintenance and adjustment of all elements.

SSR/DMTI maintenance test equipment (standard and specialized) will normally be available only at a central maintenance facility, to be transported as needed to any specific site. Essential off-the-shelf items of test equipment must be designed for this type of service. The time required to attach and set up this test equipment at the SSR/DMTI shall be considered a part of the "mean time to repair" as specified in this document.

The contractor shall furnish to the Government a list of recommended maintenance equipment (standard and specialized) and related accessories necessary for the performance of the following type SSR/DMTI maintenance functions:

3.6.27.6 Cable entry and exit locations.- All power, signal, and ground cables connecting the SSR/DMTI cabinets to external equipments shall enter and exit the SSR/DMTI at the top of the cabinet. A single cable connection area shall be provided to minimize external duct work. Cable entrances and exits shall be designed to enable advantageous routing of cables within and between cabinets from the standpoint of accessibility, serviceability, apperance of the installed equipment and noninterference with the activities of operating and maintenance personnel. All necessary connectors shall be provided. All special tools required for able fabrication or connector removal or installation shall be provided specified in (3.6.28.2.3). The length of the external equipment cables shall be as determined by the Government for the individual site receiving the SSR/DMTI modification kit.

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The contractor shall furnish to the Government a list of recommended maintenance equipment (standard and specialized) and related accessories necessary for the performance of the following type SSR/DMTI maintenance functions:

3.6.28.2.1 Special test programs and hardware.- Special test programs and hardware shall be provided in accordance with the following subparagraphs for fault diagnosis and verification of the correct operation of the Circuit Card Assemblies (CCA) and other testable assemblies of the SSR/DMTI modification equipment. These CCA's and other testable assemblies shall be able to be tested using the Autek Model 5810A Automatic Test System. The programs for the automatic test procedures for the CCA's and other testable assemblies shall be developed and delivered in accordance with paragraph 3.6.28.2.1.1 herein and shall meet the performance requirements below.

3.6.28.2.1.1 Special test programs.- The test programs and routines necessary to fully test the SSR/DMTI CCA's and other testable assemblies using the Autek 5810A Automatic Test System as required in paragraph 3.6.28.2.1 shall be provided. The programs shall be delivered on floppy discs that are fully operable and compatible with the 5810A and 5800 automatic test systems. The test routines for more than one tested assembly shall be contained on one such disc provided, however, that each such routine is complete on that disc. Where appropriate, the contractor may elect to develop and use for testing the SSR/DMTI assemblies, a modified enhanced version of the 5810A System resident software contained on each program disc. In this event, however, the identical modified software shall be provided on each SSR/DMTI program disc. In no instance shall any change in the software require software or hardware or other modification of the Autek 5810A System itself. In order to permit the FAA to enhance the effectivenss and maintain the currency of the test routines as the CCA's and other testable assemblies are modified over the life of the SSR/DMTI equipment the stored programs (including the changed system software, if applicable) shall be able to be altered on a small or large scale, or even totally rewritten using the Autek 5800 Automatic Test System programming capabilities.

3.6.28.2.1.2 Test programs.- Using the test points provided on the CCA's, and other plug-in assemblies, the test set shall be able to test (i.e., verify good or bad) and troubleshoot (i.e., fault isolate) the digital and analog circuitry on the assemblies. This process shall be automatic insofar as is practical. The test comprehensiveness shall be at least 90 percent for CCA's implemented using SSI and MSI integrated circuits. For CCA's that employ LSI devices as well as MSI and SSI devices, the test comprehensiveness shall be at least 85 percent.

Test comprehensiveness shall mean the ability to detect a stuck at high (SA1) or stuck at low (SA0) condition on any individual I.C. pin within the CCA and then isolate that fault. In addition, all LSI chips on these assemblies, shall be functionally exercised in so far as is practical.

Using the automatic test and appropriate hand-held probes or manual test equipment, it shall be possible to isolate a single failure to a single active device or a small group of active devices (integrated circuits, transistors, diodes, etc.) depending on the construction techniques used in a given test assembly. For assemblies constructed with all active components mounted in sockets, the average number of active devices in these small isolation groups shall be six or fewer per tested assembly. Specific and

written FAA approval is required of each assembly test diagnosis procedure in which the average number of active devices in the isolation groups of a tested unit exceeds six or where the test comprehensiveness is less than the allowable limit. Similar approval is required in the event the number of active devices in any one isolation group exceeds 12. Component removal in the course of troubleshooting is permitted. For assemblies constructed with one or more soldered-in active components, isolation of a fault in one of these soldered-in components shall be to that single active device.

3.6.28.2.1.3 Test hardware.- The Interface Adapter Units (IAU) required to connect the SSR/DMTI assemblies to the Autek Tester shall conform to one of the following three categories:

(a) Autek IAU's (P/N 3829 or 4376)
(b) Modified IAU design with Autek P.C. board
(c) Modified IAU design.

For the modified IAU categories (B and C), the IAU design must be made form, fit and function equivalent to the Autek IAU. Where a non-Autek P.C. board is used inthe IAU design, MIL-STD-275 shall apply except that an Autek class 05 customized board may be utilized at the contractor's option. The IAU frames shall be designed to include a durable structure, protective iridite finish, rounded edges and permanent markings identifying both the IAU and the CCA's that it tests.

The IAU's shall also meet the following design and construction requirements.

(a) Plug-in sockets and wire-wrap connections will be used to the maximum extent practical.
(b) Soldered-in devices shall be kept to a minimum.

(c) Harness and component identification (reference designations) shall be physically made on the hardware in a permanent manner.

Special attention shall be given during IAU design to human engineering factors so that the IAU setup and test operation are as simple as practical. Each IAU may adapt more than one assembly to the test set. The number of different IAU's shall be kept to the minimum necessary to do the job without making IAU set-up overly complex. It shall be possible for each IAU to be changed from one tested assembly's set-up to any other set-up for an assembly tested with that IAU in less than 3 minutes by a technician who is moderately familiar with the testing of these assemblies.

All IAU adjustment and adaptation controls shall be implemented using dipswitches, toggle switches and rotary controls. In the event the complexity of any IAU is such that it is comprised of more than 40 active devices, it shall be able to be tested as if it were a tested SSR/DMTI assembly. Each IAU shall have at least 10 percent of its useable connector pins, cable wires and component mounting area left spare and available for future use by the Government.

All power supplies and the interconnecting cables required to connect them and the tested assemblies to the IAU's and/or the Autek Tester shall be provided. The power supplies, which may be commercial off-the-shelf supplies, shall be housed in a single assembly for desk top mounting. The assembly and its constituent supplies, cables, connectors, jack, etc., shall be marked to identify these items. It shall carry a nameplate similar to those on the SSR/DMTI equipment, be constructed of steel or aluminum and finished as required above for the IAU's. Adequate cooling of the supplies shall be provided. The assembly shall include a circuit breaker and all necessary cables.

A single cabinet for IAU and power supply storage shall be provided for each set of IAU's and power supplies. The cabinet will meet best commercial practices.

3.6.28.2.2 Plug-in assembly extenders.- The contractor shall provide appropriate extender devices (a minimum of three of each type per site) that permit plug-in assemblies which are normally inaccessible, to be extended such that all parts and wiring are accessible to maintenance personnel) and test equipment. The extender shall be polarized to prevent incorrect insertion, but shall not be keyed in a manner which would preclude using extenders on all assemblies with the same connector type. Plug-in assemblies with voltages in excess of 150 volts or connector currents in excess of 5 amperes shall not require extension.

The contractor shall prepare a supplement to the SSR/DMTI manuscript plan for the Hardware Supplement Manual (3.6.33.2.4.1), the SSR/DMTI Supplement for Autek 5810A Operation and Maintenance Manual (3.6.33.2.4.2), and the Special Test Program Software Manual (3.6.33.2.5.1). This manuscript plan supplement shall be prepared using charts, graphs, and narratives to describe the contractor's plan for developing and delivering the required documentation for the, special test programs and hardware. Typical drawings and test of the proposed manuals shall be included in the plan. The plan shall include a schedule for manuscript preparation, review, and validation. The events and submission dates the contractor proposes for assuring that printed instruction books will be available for delivery with the equipment in accordance with the contract schedule shall be depicted. The schedule shall indicate preparation time, in-process review time, validation time, and final review time.

3.6.28.2.3 Special tools and ancillary items.- The contractor shall provide all of the special tools and ancillary items needed to support the installation, maintenance, and adjustment of the SSR/DMTI.

3.6.28.2.4 Other equipment.- The contractor shall provide all other components identified as specialized test equipment elsewhere in this specification.

3.6.29 Spare parts.- As established in the contract schedule, the contractor shall provide spare parts in accordance with the following subparagraphs. A provisioning conference may result in modification to the requirements herein,

3.6.29.1 Spare parts.- The contractor shall supply as site spares a quantity of each circuit card assembly (whether wired-in or plugged-in), each plug-in assembly (such as power regulator, analog-to-digital converter, stalo assembly, or similar unit) and each PROM or other device which stores a computer program or other data used in the SSR/DMTI. The spare ROM's, PROM's, and similar devices shall be programmed and capable of immediate operation in the SSR/DMTI equipment. For logistic support purposes, all PROM's and similar devices containing different internal data sets (programs) shall be treated as separate and individual parts even if they are identified by the same vendor part number (e.g., 2708). Standard or common parts and assemblies including cathode ray tubes, LED display panels, keyboards and the like, are specifically excluded from the site spare package. Included in the site spares package shall be quantities of all replaceable parts and assemblies which are unique to the SSR/DMTI. These items shall be "parts-peculiar" as defined in paragraph 3.1.5 of FAA-G-1375 except that cable assemblies, wiring, meters, hardware, card bins, gears, and similar items are added to the list of the parts which are excluded in the definition.

The quantity of spares provided for each PROM's, CCA's, and plug-in assembly shall be 5 percent of the total quantity of that item used in the equipment delivered to a given site. When the calculation results in a mixed number, the quantity provided shall be the next larger integer; in no case, however, shall less than two, nor more than eight of any item be delivered as spares to any one site. A quantity of one each peculiar replaceable part or assembly shall be included in the site spares.

Where the system design requires the replacement of any part, subassembly, or assembly not included in the above categories in order to meet the maintainability requirements herein (3.6.30), such items shall be considered to be peculiar parts for provisioning purposes. One each of such parts shall be included in the site spares package.

These spares shall be delivered as required by the contract schedule.

3.6.29.2 Depot spares.- The contractor shall provide quantities of peculiar parts as depot-level spares as established in the contract schedule. The quantities provided shall be as required by paragraphs 3.3, 3.3.1, and 3.3.2 of FAA-G-1375. Unique, replaceable items and all other items considered to be peculiar parts in 3.6.29.1 herein shall be provided in quantities required by FAA-G-1375.

3.6.30 Reliability and maintainability.- The installed modification kit shall not degrade the operational availability of the ARSR-1, -2 series of radar systems or the FPS-20 family series of radar systems as utilized by the FAA. The present FAA user operational availability of VT ARSR is 99.35 percent. The operational SSR/DMTI, Type I, II, and III, modification kit shall meet or exceed the following reliability and maintainability requirements:

(a)	MTBF	3,000 hours
(b)	MTTR	0.5 employee-hours
(c)	MBRT	Mean time 4 hours, maximum time 8 hours

3.6.29.1 Spare parts.- The contractor shall supply as site spares a quantity of each circuit card assembly (whether wired-in or plugged-in), each plug-in assembly (such as power regulator, analog-to-digital converter, stalo assembly, or similar unit) and each PROM or other device which stores a computer program or other data used in the SSR/DMTI. The spare ROM's, PROM's, and similar devices shall be programmed and capable of immediate operation in the SSR/DMTI equipment. For logistic support purposes, all PROM's and similar devices containing different internal data sets (programs) shall be treated as separate and individual parts even if they are identified by the same vendor part number (e.g., 2708). Standard or common parts and assemblies including cathode ray tubes, LED display panels, keyboards and the like, are specifically excluded from the site spare package. Included in the site spares package shall be quantities of all replaceable parts and assemblies which are unique to the SSR/DMTI. These items shall be "parts-peculiar" as defined in paragraph 3.1.5 of FAA-G-1375 except that cable assemblies, wiring, meters, hardware, card bins, gears, and similar items are added to the list of the parts which are excluded in the definition.

The quantity of spares provided for each PROM's, CCA's, and plug-in assembly shall be 5 percent of the total quantity of that item used in the equipment delivered to a given site. When the calculation results in a mixed number, the quantity provided shall be the next larger integer; in no case, however, shall less than two, nor more than eight of any item be delivered as spares to any one site. A quantity of one each peculiar replaceable part or assembly shall be included in the site spares.

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These spares shall be delivered as required by the contract schedule.

3.6.29.2 Depot spares.- The contractor shall provide quantities of peculiar parts as depot-level spares as established in the contract schedule. The quantities provided shall be as required by paragraphs 3.3, 3.3.1, and 3.3.2 of FAA-G-1375. Unique, replaceable items and all other items considered to be peculiar parts in 3.6.29.1 herein shall be provided in quantities required by FAA-G-1375.

3.6.30 Reliability and maintainability.- The installed modification kit shall not degrade the operational availability of the ARSR-1, -2 series of radar systems or the FPS-20 family series of radar systems as utilized by the FAA. The present FAA user operational availability of VT ARSR is 99.35 percent. The operational SSR/DMTI, Type I, II, and III, modification kit shall meet or exceed the following reliability and maintainability requirements:

(a)	MTBF	3,000 hours
(b)	MTTR	0.5 employee-hours
(c)	MBRT	Mean time 4 hours, maximum time 8 hours

(e) Relevant failure - any failure that does not fall into one of the categories listed under (d) above shall be recorded as a relevant failure. specifically included are failures due to parts defects, degradation due to out-of-tolerance conditions, transients and unknowns.

3.6.30.2 Maintenance approach.- Ease and speed of repairs is required so that maximum availability of the SSR/DMTI can be achieved. Immediate indication of the need for maintenance is essential to provide the optimum performance from the SSR/DMTI equipment.

Accordingly, the SSR/DMTI equipment shall be designed so that the off-line channel can be completely maintained with no interruptions to the correct processing of the radar signals by the on-line equipment, within the limits established by the availability requirement. The maximum effort allowed for preventive maintenance for the operational SSR/DMTI equipment shall not exceed 2.0 employee hours per month. This time shall include preparation and active working time but shall not include bench repair time.

All electronic and mechanical parts and equipment shall be designed and fabricated to minimize the time, skill, and experience necessary to repair and maintain them. The corrective maintenance approach shall, to the maximum extent possible, be to localize the failures through the use of built-in-test maintenance features, and to remove and replace the failed element, CCA, or plug-in assembly using the site spares stocks. The actual repair of the failed unit shall be accomplished in a designated bench repair area using the appropriate maintenance equipment (3.6.28).

3.6.31 Reliability program.- The contractor's reliability program shall insure that the reliability requirements of 3.6.30 are met or rxceeded. It shall be conducted in accordance with the requirements in the following subprograms.

3.6.31.1 Reliability program plan.- The contractor shall prepare a reliability plan which fully describes its plan to conduct a reliability program which meets the requirements herein. The plan shall contain the information required in Tasks 101, 102, 103, 104, 201, 202, 203, 204, 207, and 209 of MIL-STD-785.

3.6.31.2 Reliability program management.- The contractor's reliability management organization and control shall be in accordance with Task 101:

(a) Organization - The head of the reliability management organization shall have the necessary authority, resources, and access to higher management to enable him or her to implement and enforce the action required to meet the requirements specified herein.

(b) Subcontractor and supplier control - To the extent necessary to satify the requirements herein, all subcontractors and suppliers shall be bound by the prime contractor to these same reliability program requirements. All proposed deviations shall be presented to, and approved by, the FAA program office before such products or processes are incorporated into production equipment. Formal design reviews shall be conducted by the prime contractor with subcontractors and suppliers. Provisions shall be made for participation by FAA personnel as required in the contract schedule.

3.6.31.3 Reliability program tasks.- The contractor's reliability program shall, as a minimum, include the tasks specified in the following subparagraphs.

3.6.31.3.1 Design techniques.- Using the techniques of task 207 of MIL-STD-785, the SSR/DMTI equipment shall be designed such that each part and component is operated well within its design ratings. The parts shall not be subjected to conditions during operation, transit, or storage which exceed the values obtained when the device's maximum ratings have been reduced (derated) as required by this subprogram or 3.6.27.9, whichever is more restrictive. No part shall operate at more than 50 percent of its voltage-temperature and power dissipation-temperature stress ratings. The operating temperature for temperature-constrained parts shall be at least 10°C below the device's maximum operating temperature. The operating temperatures used for these ratings shall be +50°C plus the appropriate internal temperature rise when the devices are operated in the equipment with its doors closed, or +30°C plus the internal temperature rise with the doors open and parts extended for accessibility, whichever is greater.

Parts shall be selected as specified in 3.6.27 herein, using Task 207 of MIL-STD-785 as a guide in obtaining parts which meet the applicable reliability requirements herein.

3.6.31.3.2 Thermal design analysis.- The contractor shall analyze the thermal design of SSR/DMTI equipments. The analyses shall provide the necessary means to assure that the design and all parts, components, and materials meet the requirements of 3.5.2 and subparagraphs 3.6.27.5.4, and 3.6.31.3.1 herein.

An analysis of each power supply shall be accomplished. They shall consider all electronic parts and current carrying hardware (lugs, bolts cables, etc.), including insulating and other materials used with or within one inch (2.54 cm) of these components. Each circuit card assembly and plug-in module shall be diagnosed to determine typical power dissapation per assembly and major current carriers and dissipators on the assembly. For digital logic cards, and similar assemblies, estimated power dissipation per board shall be provided.

(b) Subcontractor and supplier control - To the extent necessary to satify the requirements herein, all subcontractors and suppliers shall be bound by the prime contractor to these same reliability program requirements. All proposed deviations shall be presented to, and approved by, the FAA program office before such products or processes are incorporated into production equipment. Formal design reviews shall be conducted by the prime contractor with subcontractors and suppliers. Provisions shall be made for participation by FAA personnel as required in the contract schedule.

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An analysis of each power supply shall be accomplished. They shall consider all electronic parts and current carrying hardware (lugs, bolts cables, etc.), including insulating and other materials used with or within one inch (2.54 cm) of these components. Each circuit card assembly and plug-in module shall be diagnosed to determine typical power dissapation per assembly and major current carriers and dissipators on the assembly. For digital logic cards, and similar assemblies, estimated power dissipation per board shall be provided.

modes of failure for each replaceable element shall be injected into the analysis to ascertain critical areas based on the functions performed and the expected failure rates. The results of the analysis shall be used by the contractor to evaluate the reliability model, detect cirtical areas and, if necessary, determine appropriate design changes. Items which are citical to the reliable operation of SSR/DMTI shall be identified and handled as required by Task 204 of MIL-STD-785. Particular attention shall be paid to redundant applications to ensure that the redundancy is not invalidated by obscure circuit effects or sneak paths. The contractor's reliability engineers shall work with the hardware and software design engineers on a continuing basis to accomplish at least the following:

(a) Identification of system, subsystem, and component failure modes.

(b) Identification of probable causes of failure.

(c) Identification of the effects of failures on the system operation and functions.

(e) Determination of failure modes rates.

(f) Recommendation of appropriate corrective features such as redundant elements, failsafe or failsoft designs, and selection of more reliable parts.

(g) Assistance in the formulation of test criteria to be used, in light of the identified critical failure modes.

The results of the analysis shall be provided as specified in (3.6.33.2.1.2).

3.6.31.3.7 Effects of storage and handling.- The effects on reliability of storage (including shelf life) packaging, transportation, handling, and maintenance actions shall be assessed and incorporated into the reliability program in accordance with Task 209 of MIL-STD-785.

3.6.31.3.8 Design reviews.- The contractor shall be prepared to explain and fully discuss its reliability program at SSR/DMTI design reviews as established by the contract schedule. The reliability portion of the design reviews shall include, as a minimum, information of the type required by Task 203 of MIL-STD-785.

3.6.31.3.9 Failure reporting, analysis, and correction.- The contractor shall establish a closed-loop procedure for the reporting and correction of failures in SSR/DMTI both in factory and at the site. The reporting shall be accomplished in accordance with Task 104 of MIL-STD-785, except where deviations are fully justified in the reliability program plan, and approved by the Government before the beginning of equipment production. As a minimum, all failures occurring after the time that the individual

equipment's design is frozen and before the final acceptance of each SSR/DMTI modification kit shall be reported and corrected. The contractor shall statistically analyze each reported failure and ascertain its cause or causes. Each analysis shall also include the identification of any reliability trends. Failure data reports to the component level that include the results of individual and trend analyses shall be maintained in a centralized file to which the Government has unlimited access. Summaries of failures shall be prepared and shall include the identification of each failure, the results of each failure analysis, the equipment failure, the results of each failure analysis, the equipment failure mode and symptoms, the cause of the failure and any corrective action taken, planned or recommended. The status of the corrective action and a statement as to the failure's relevance to any test (maintainability, reliability or similar tests), as well as a description of any discernible trends or patterns shall also be included. The failure summaries shall be included in the final test reports (3.6.33.2.1.2).

The prime contractor shall establish a similar procedure for reporting of all failures in all deliverable subcontractor items which equal or exceed the complexity of a typical plug-in assembly. This reporting procedure shall commence with the first application of power to the unit. All failure reports of subcontractor items shall be traceable to the SSR/DMTI equipment in which the item is to be used.

3.6.31.3.10 Reliability status.- The contractor shall prepare and submit reliability status reports in accordance with Task 103 of MIL-STD-785 and (3.6.33.2.1.2) herein.

3.6.31.4 Maintainability program.- The contractor's maintainability program shall insure that the maintainability and, in conjunction with the reliability program, the availability requirements of 3.6.30 are met or exceeded. It shall be conducted in accordance with the requirements of the following subprographs.

3.6.31.4.1 Maintainability program plan.- The contractor shall prepare a maintainability program plan which fully describes its plans to conduct a maintainability program which meets the requirements herein. The plan shall conform to the requirements of paragraph 5.1 of MIL-STD-470 except where limited herein. The plan shall also address the following topics:

(a) Cost tradeoffs and reliability considerations involved in the application of both corrective and preventive maintenance.

(b) Number and skill levels of personnel required to maintain the SSR/DMTI.

(c) Level of diagnostic support.

(d) CCA problem analysis and field repair techniques.

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The prime contractor shall establish a similar procedure for reporting of all failures in all deliverable subcontractor items which equal or exceed the complexity of a typical plug-in assembly. This reporting procedure shall commence with the first application of power to the unit. All failure reports of subcontractor items shall be traceable to the SSR/DMTI equipment in which the item is to be used.

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3.6.31.4.1 Maintainability program plan.- The contractor shall prepare a maintainability program plan which fully describes its plans to conduct a maintainability program which meets the requirements herein. The plan shall conform to the requirements of paragraph 5.1 of MIL-STD-470 except where limited herein. The plan shall also address the following topics:

(a) Cost tradeoffs and reliability considerations involved in the application of both corrective and preventive maintenance.

(b) Number and skill levels of personnel required to maintain the SSR/DMTI.

(c) Level of diagnostic support.

(d) CCA problem analysis and field repair techniques.

3.6.31.4.3.4 Maintainability design tradeoffs.- During the design and development of the SSR/DMTI, the contractor shall include maintability considerations in all designs tradeoffs in accordance with paragraph 5.5 of MIL-STD 470. In addition, the following tradeoffs shall be included.

(a) Self-test effectiveness versus acquisition costs.

(b) Self-test effectiveness versus logistic support costs.

(c) Implementation of plug-in and replaceable assemblies versus improvement in MTTR.

(d) Repairing versus discarding of CCAs and other plug-in assemblies.

(e) System design to facilitate troubleshooting by signature analysis techniques versus traditional design and maintenance techniques.

The results and detailed computations of the tradeoff studies shall be provided as specified in (3.6.33.2.1.5).

3.6.31.4.3.5 Maintainability predictions.- The contractor shall make maintainability predictions and establish the appropriate preventative maintenance requirements in accordance with paragraph 5.6 of MIL-STD-470. Preliminary predictions of mean corrective and preventive maintenance times shall be provided as specified in (3.6.33.2.1.5). The predictions shall be updated and refined during the design and development stages. An early design prediction shall be prepared in accordance with Procedure III of MIL-HDBK-472 and a final design prediction shall be prepared in accordance with Procedure II, Part B of the same handbook. The procedures, accomplishment times, and schedules of each of the recommended or established preventive maintenance tasks shall be included in the early and final design predictions. The early and final design predictions shall be provided as specified in (3.6.33.2.1.5).

3.6.31.4.3.6 Design reviews.- The contractor shall be prepared to explain and fully discuss its maintainability program at the SSR/DMTI design reviews at established by the contract schedule. The maintainability portion of the design reviews shall include, at a minimum, information of the type required by paragraph 5.9 of MIL-STD-470, and the following:

(a) Current maintainability estimates and achievements as derived from predictions or tests.

(b) Status and description of the Maintainability Program Plan.

(c) Results of the design tradeoffs studies.

(d) Effects of engineering and management decisions and changes upon maintainability achievements, trends, and potentials.

3.6.31.4.3.4 Maintainability design tradeoffs.- During the design and development of the SSR/DMTI, the contractor shall include maintability considerations in all designs tradeoffs in accordance with paragraph 5.5 of MIL-STD 470. In addition, the following tradeoffs shall be included.

(a) Self-test effectiveness versus acquisition costs.

(b) Self-test effectiveness versus logistic support costs.

(c) Implementation of plug-in and replaceable assemblies versus improvement in MTTR.

(d) Repairing versus discarding of CCAs and other plug-in assemblies.

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The results and detailed computations of the tradeoff studies shall be provided as specified in (3.6.33.2.1.5).

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(a) Current maintainability estimates and achievements as derived from predictions or tests.

(b) Status and description of the Maintainability Program Plan.

(c) Results of the design tradeoffs studies.

(d) Effects of engineering and management decisions and changes upon maintainability achievements, trends, and potentials.

(e) General apperance of installation, (includes workmanship, location of all installed kit material, accessibility and markings on equipment).

(f) Ease of installation, including total downtime.

(g) Successful completion of tests.

(h) Verification of adjustment procedures and test points in accordance with instruction book.

(i) Quality control.

3.6.32.2 Air traffic control (ATC) operating constraints.- When the installation and testing of equipment is performed in an operating environment, ATC activities and services shall have a priority over all contract activities. There shall be no compromise in the safe and timely control of aircraft during these phases. The design of installation and testing procedures shall be based on the continued use of existing operating channel of the VT ARSR. Installation services shall be performed in such a manner that disruptions to operating ATC facilities shall be minimized. Contractor actions that will interfere with or in any way have an impact on ATC activities and services shall be coordinated with and approved by the Contracting Officer or his designated representative in advance. The installation plan which shall be furnished by the contractor, shall detail a proposed procedure for minimal interruption of radar service while the contractor is installing, testing, and integrating the SSR/DMTI equipment. The installation plan shall assume that any work requiring shutdown of the operating VT ARSR radar service shall be accomplished during the hours of 10:00 p.m. until 6:00 a.m., based on specific and prior Government approval.

3.6.32.3 Equipment and services to be provided by the contractor.- The contractor shall provide the services and materials necessary to install, align, test, and integrate the SSR/DMTI as required by this specification. These activities shall occur at those sites and at the times specified by the contract. The work to be performed shall include installation and checkout of existing Government furnished equipment as part of the overall contractor system installation, integration and checkout efforts. The work shall also include equipment, unit and subsystem interconnections, testing and demonstration of the ability of the integrated system to meet specified system performance requirements. The work shall be planned so as to assure efficient integration with existing radars and ATC facilities. Onsite work shall be scheduled and conducted so as to impose negligible impact to ongoing operational activities. In addition, the contractor shall provide all necessary services and material to prepare, reproduce, and provide reports, computer programs, and documentation as necessary to successfully complete the installation and integration effort. Any feature or item necessary for performing this task in accordance with the requirements of the contract shall be incorporated even though that item or feature may not be specifically described herein.

3.6.32.3.1 Integration into the NAS.- When required by the contract schedule, the contractor shall be responsible for the integration of the operational SSR/DMTI equipment into the National Airspace System (NAS) as specified herein. The contractor shall supply all services and materials to verify proper operationa of the SSR/DMTI equipment. The contractor shall align and adjust the SSR/DMTI for its optimum performance according to the equipment and operating parameters and requirements of each operational facility. Computer diagnosis of SSR/DMTI data will be provided as appropriate by the using ARTCC. The contractor shall participate in meetings and conferences and provide technical data fully describing the SSR/DMTI's performance and design compatibility with the associated equipment as may be directed by the Contracting Officer. The contractor shall prepare SSR/DMTI integration test procedures (3.6.33.1.10) which fully describes the adjustments and procedures required for integration of SSR/DMTI into the NAS.

3.6.33 Documentation.- The contractor shall provide all necessary services and materials to develop and deliver such documentation as is specified herein, in the forms and quantities and at the times that are required by the contract schedule. All documentation specified herein shall be periodically updated during the entire life of the contract to reflect the latest design, plans, test results and similar data. In the event that the documentation requiring change has been formally submitted to and accepted by the Contracting Officer, the appropriate revision shall be provided in the same quality and quantity as the earlier submission. The revision shall be in the form of replacement or change pages or, if more than 50 percent of the document requires reprinting to provide the change pages, the total document shall be reprinted and submitted with the appropriate revision notation and the dates of both the original and the revised submission. Each changed page shall be clearly identified with its change date, and shall bear margin or other markings clearly identifying the changed material.

All documentation produced, updated or delivered by the contractor shall conspicuously show the contractor and contract number. The identification shall be on the front page of each bound document on each page of loose-leaf and single-sheet documents as as drawings.

All reproducibles furnished shall be of such quality as to permit at least two generations of legible copies to be made by the intended reproduction process. The copies shall be legible in every character in every part of the page. Reproducible of the sepia type shall have a minimum background or field intensity with no burned or unintended dark or shaded areas.

All documents shall be prepared using correct English and a minimum of abbreviations and acronyms. Correct spelling (e.g., "through" instead of "thru") and punctuation shall be used in clear, direct sentences. Effective and unambiguous communication of the intended information shall be the goal of each document.

3.6.33.1 System documentation.- The following subparagraphs specify the general documentation requirements for the SSR/DMTI equipment. Such additional information as may be requested by the Government in accordance with paragraphs 4.6 and 4.7 of FAA-G-2100 shall also be provided.

3.6.33.1.1 Not used.-

3.6.33.1.1.1 Not used.-

3.6.33.1.1.2 Not used.-

3.6.33.1.2 System design data.- System design data shall be submitted for Government review in accordance with the contract schedule. The submission shall be organized to reflect the contractor's approach to the total system design and shall be organized in a logical sequence to reflect the hardware and software design approach. All pages within sections shall be sequentially numbered. The submission of design data shall not be used to produce modifications or alternatives to details of the specification or a change in the scope of the contract. The design data shall included all elements of the equipment to be supplied by the contractor under the terms of the contract, as detailed by this specification and any addenda hereto, together with all interfaces with other equipment. A summary of equipment operational characteristics shall be included. Acceptance of the design data does not relieve the contractor of any responsibility to meet the requirement in this specification. Bather, it requires the design data to reflect the intended and actual design of the equipment.

3.6.33.1.2.1 System description.- The design data shall include a description of the overall system and each hardware and software module, detailing their interaction and operational capabilities necessary to meet all functional requirements.

3.6.33.1.2.2 Block diagrams.- A complete set of equipment block diagrams shall be provided by the contractor. The block diagrams shall show the general operational, electrical, and physical relationships of the eqipment elements.

3.6.33.1.2.3 Information logic flow diagrams.- The contractor shall provide complete information logic flow diagrams. These diagrams shall show the detailed logical, operational, and functional relationships of the equipment elements. Symbology used in these diagrams shall be fully explained in the basic document. The functions of the self-test features shall also be described. As an alternative, software coding and modules may be described in pseudo-code or a program language compatible with the language used.

3.6.33.1.2.4 Input-output details.- The contractor shall provide data which consolidates all equipment interfaces and input-output characteristics. This shall include: radar transmission characteristics, external interface signal characteristics and limits, timing diagrams, and power requirements. This data shall include all major intra-system, as well as external interfaces. All human-machine interfaces, such as front panel control layouts, and all similar functions, shall be provided.

3.6.33.1.1 Not used.-

3.6.33.1.1.1 Not used.-

3.6.33.1.1.2 Not used.-

3.6.33.1.2 System design data.- System design data shall be submitted for Government review in accordance with the contract schedule. The submission shall be organized to reflect the contractor's approach to the total system design and shall be organized in a logical sequence to reflect the hardware and software design approach. All pages within sections shall be sequentially numbered. The submission of design data shall not be used to produce modifications or alternatives to details of the specification or a change in the scope of the contract. The design data shall included all elements of the equipment to be supplied by the contractor under the terms of the contract, as detailed by this specification and any addenda hereto, together with all interfaces with other equipment. A summary of equipment operational characteristics shall be included. Acceptance of the design data does not relieve the contractor of any responsibility to meet the requirement in this specification. Bather, it requires the design data to reflect the intended and actual design of the equipment.

3.6.33.1.2.1 System description.- The design data shall include a description of the overall system and each hardware and software module, detailing their interaction and operational capabilities necessary to meet all functional requirements.

3.6.33.1.2.2 Block diagrams.- A complete set of equipment block diagrams shall be provided by the contractor. The block diagrams shall show the general operational, electrical, and physical relationships of the eqipment elements.

3.6.33.1.2.3 Information logic flow diagrams.- The contractor shall provide complete information logic flow diagrams. These diagrams shall show the detailed logical, operational, and functional relationships of the equipment elements. Symbology used in these diagrams shall be fully explained in the basic document. The functions of the self-test features shall also be described. As an alternative, software coding and modules may be described in pseudo-code or a program language compatible with the language used.

3.6.33.1.2.4 Input-output details.- The contractor shall provide data which consolidates all equipment interfaces and input-output characteristics. This shall include: radar transmission characteristics, external interface signal characteristics and limits, timing diagrams, and power requirements. This data shall include all major intra-system, as well as external interfaces. All human-machine interfaces, such as front panel control layouts, and all similar functions, shall be provided.

(b) Design qualification tests

(1) General characteristics tests

(2) Environmental tests

(3) Reliability test and demonstration

(4) Maintainability tests

(c) Type tests

(1) Performance tests - The performance tests shall demonstrate that the equipment fully satisfies the detailed performance requirements specified herein.

(2) Production reliability verification tests - The production reliability verification tests shall be conducted in accordance with the reliability tests plan's requirements for verification of the reliability of production equipment.

(3) Temperature and humidity tests - The equipment shall be tested to insure its operation over the temperature and humidity service conditions (3.5.2.1)

(d) Production tests - The production or factory acceptance tests shall be similar to the performance type test, but shall be conducted at a higher (e.g., module and system) level. It shall verify that the major requirements of the performance type test are being consistently met.

(e) Onsite tests and integration tests - The onsite of "final sell-off" tests shall be similar to the production tests except that the reliability tests shall not be repeated. In addition, the integration test shall demonstrate the correct operation of the SSR/DMTI with its associated radar and associated ARTCC's.

The Government will review and approve the qualification and acceptance test plan as established in the contract schedule. Once approved, the plan shall be used by the contractor as the basis for developing the detailed equipment and computer program test procedures and data sheets (3.6.33.1.4)

3.6.33.1.3.1 Reliability test plan.- An integrated reliability test demonstration plan shall be prepared in accordance with paragarphs 5.3.1 and 5.3.3 of MIL-STD-785 and the requirements of the reliability program plan as provided by (3.6.31.1) herein. The plan shall provide specific and detailed test objectives and a thorough discussion of the techniques and methods which are to be used to meet these objectives and the testing requirements of (4.3.3.3) herein.

3.6.33.1.3.2 Maintainability test plan.- The contractor shall prepare a maintainability demonstration test plan in accordance with paragraph 5.11 of MIL-STD-470, paragraph 4.2 of MIL-STD-471, and the requirements herein. The plan shall provide specific test objectives and a thorough discussion of the metods to be used to meet these objectives and the testing requirements of (4.3.3.4) herein.

3.6.33.1.4 Equipment and computer test procedures.- The contractor shall prepare comprehensive test procedures which include all details necessary to assure that the test procedures and testing thereto will satisfactorily demonstrate equipment and system compliance with all functional, environmental, electrical, mechanical, reliability, mantainability, and performance requirements as contained in this specification. Each test of the test procedure shall reference the specific requirements of this specification and the appropriate test plan which are to be verified by the tests described. The test criteria, demonstration test procedures, test methods, data collection procedures and reporting requirements for the reliability and maintainability tests shall be in accordance with their respective program plans. The test procedures and data sheets shall comply with the requirements of paragraph 2.2 and associated subparagraphs of FAA-STD-013.

Once approved by the Government, these procedures shall be utilized to conduct all testing required in 4.1 herein, except for the integration tests which have a separate test procedures document (3.6.33.1.10).

3.6.33.1.5 Final test reports.- Upon completion of each test defined by the approved test plans and procedures, the test results shall be recorded and submitted to the FAA. The test report shall contain a complete description of the test results. The test report shall contain the data required by the applicable test plan as well as the following information:

(a) Copies of the test data sheets.

(b) A description of the performance of each equipment under test and whether it meets the system limits.

(c) Functions that were tested.

(d) Information as to whether the results of the test are in agreement with the required maintainability and reliability of the unit or system.

(e) A record of any engineering chages found necessary to correct design deficiencies.

(f) Copies of all discrepancies noted during the test along with the dispositions accepted and approved by the Government.

(g) Copy of all deviations from the approved test procedures required during the testing, with reason for deviation attached.

(h) Copies of all failure reports on components in the equipment under test.

3.6.33.1.6 Site preparation reports.- The contractor shall submit a site preparation report, where required by the contract schedule, for each site receiving a SSR/DMTI modification kit. Where the requirements of the installation are identical, a single report may apply to multiple sites. The site preparation report will be used by the Government to prepare the site for installation of the contractor's equipment and to perform necessary services not required of the contractor. Therefore, all requirements to prepare the site for installation of the equipment shall be included. The report shall include but not be limited to the following:

(a) Typical floor plan layouts of SSR/DMTI cabinet(s) and equipment.

(b) List of the SSR/DMTI equipment and tools to be delivered to site by the contractor.

(c) Tabulation of the mechanical and electrical characteristics of each piece of equipment. Included shall be the definition of power requirements, circuit breaker panels, heat load in BTU per hour, starting surge current data, circuit breaker requirements, and power factors. The overall dimensions and weights (crated and uncrated) and any other information needed for the Government to prepare for the equipment installation shall be provided

(d) Definition of cable and connector requirements for the complete installation, including typical cable access points and routing.

(e) Definition of any office equipment and space required by the contractor during the installation and checkout period,

(f) Identification of requirements for Government services and test equipment, if any.

(g) List of temporary test equipment, if any, which will be supplied by the contractor.

(h) A tabulation of typical or estimated work schedules, requirements, and plans.

(i) List of cabinets and modules to be removed.

(g) Copy of all deviations from the approved test procedures required during the testing, with reason for deviation attached.

(h) Copies of all failure reports on components in the equipment under test.

3.6.33.1.6 Site preparation reports.- The contractor shall submit a site preparation report, where required by the contract schedule, for each site receiving a SSR/DMTI modification kit. Where the requirements of the installation are identical, a single report may apply to multiple sites. The site preparation report will be used by the Government to prepare the site for installation of the contractor's equipment and to perform necessary services not required of the contractor. Therefore, all requirements to prepare the site for installation of the equipment shall be included. The report shall include but not be limited to the following:

(a) Typical floor plan layouts of SSR/DMTI cabinet(s) and equipment.

(b) List of the SSR/DMTI equipment and tools to be delivered to site by the contractor.

(c) Tabulation of the mechanical and electrical characteristics of each piece of equipment. Included shall be the definition of power requirements, circuit breaker panels, heat load in BTU per hour, starting surge current data, circuit breaker requirements, and power factors. The overall dimensions and weights (crated and uncrated) and any other information needed for the Government to prepare for the equipment installation shall be provided

(d) Definition of cable and connector requirements for the complete installation, including typical cable access points and routing.

(e) Definition of any office equipment and space required by the contractor during the installation and checkout period,

(f) Identification of requirements for Government services and test equipment, if any.

(g) List of temporary test equipment, if any, which will be supplied by the contractor.

(h) A tabulation of typical or estimated work schedules, requirements, and plans.

(i) List of cabinets and modules to be removed.

3.6.33.1.12 Not Used.

3.6.33.2 Hardware documentation.- The following subparagraphs specify the documentation requirements for the SSR/DMTI hardware.

3.6.33.2.1 Reliability and maintainability documentation.- The contractor shall document and provide the results of its reliability and maintainability programs as specified herein.

3.6.33.2.1.1 Reliability program plan.- The contractor shall prepare a reliability program plan as specified in (3.6.31.1). A preliminary plan shall be submitted with the bidder's proposal as required by the solicitation. Upon approval by the Government, the preliminary plan shall become the basis for a final program plan which shall be submitted as established in the contract schedule.

3.6.33.2.1.2 Reliability status report.- The contractor shall prepare reliability status reports as specified in (3.6.31.3.10). As they become available, the results of the following reliability program tasks 'shall be fully presented in the status reports:

(a) Thermal design analysis (3.6.31.3.2)

(b) Reliability requirements allocation (3.6.31.3.3)

(c) Reliability predictions (3.6.31.3.4)

(d) Total logistic predicitions (3.6.31.3.5)

(e) Failure modes, effects, and criticalness analysis (3.6.31.3.6)

(f) Failure summaries (e.6.31.3.9)

3.6.33.2.1.3 Maintainability program plan.- The contractor shall prepare a maintainability program plan as specified in (3.6.31.4.1). A preliminary plan which includes-the preliminary maintenance predictions required by (3.6.31.4.3.5) shall be submitted with the bidder's proposal as required by the solicitation. Upon approval by the Government, the preliminary plan shall become the basis for a final program plan which shall be submitted as established in the contract schedule.

3.6.33.2.1.4 Maintainability concept plan.- The contractor shall submit the maintenance concept plan (3.6.31.4.3.2) to the Government for approval as established n the contract schedule. The approved plan shall be incorporated into the remainder of the maintainability program as established by the approved maintainability program plan.

3.6.33.2.1.5 Maintainability status report.- The contractor shall prepare maintainability status reports as specified in (3.6.31.4.3.8). As they become available, the results of the following maintainability program tasks shall be fully presented in the status reports:

(a) Maintainability design tradeoffs (3.6.31.4.3.4)

(b) Maintainability predictions (3.6.31.4.3.5)

3.6.33.2.2 Equipment instruction books.- The contractor shall prepare a manuscript plan and the draft and final, reproducible manuscripts for the SSR/DMTI equipment instruction books as established in the contract schedule. The manuscript plan and its schedule shall be prepared in accordance with paragaph 1-3.3 and its subparagraph of FAA-D-2494/1, except that a minimum of 3 months shall be allowed for Government printing of instruction books. The plan shall include sample drawings and text of the type proposed foruse in the software documentation and equipment instruction books. The contractor's procedures are validation plan required by paragraphs 1-4.2.3 and 1-4.2.7.2 of FAA-D-2494/1 respectively, shall be included in the manuscript plan. Upon approval by the Government, the plan shall, subject to and in conjunction with this specificaion and contract, be binding on the contractor. The contractor shall prepare a supplement to the SSR/DMTI manuscript plan for the Hardware Supplement Manual (3.6.33.2.4.1), the SSR/DMTI Supplement for Autek 5810A Operation and Maintenance Manual (3.6.33.2.4.2), and the Special Test Program Software Manual (3.6.33.2.5.1). This manuscript plan supplement shall be prepared using charts, graphs and narratives to describe the contractor's plan for developing and delivering the required documentation for the special test programs and hardware. Typical drawings and text of the proposed manuals shall be included in the plan. The plan shall include a schedule for manuscript preparation, review and validation. The events and submission dates the contractor proposes for assuring that printed instruction books will be available for delivery with the equipment in accordance with the contract schedule shall be depicted. The schedule shall indicate preparation time, in-process review time, validation time, and final review time.

The SSR/DMTI instruction book shall include sufficient level of detail on the hardware to provide a thorough understanding of all SSR/DMTI functions. Its organization, content and level of detail shall be such that the equipment internal problems and problems concerning the iterfaces with external systems and devices are able to be diagnosed and remedied by maintenance personnel who were trained using the instruction book as a text. The manuscripts for the instruction books shall be prepared in accordance with FAA-D-2494/1 and FAA-D-2494/2 as modified herein. The use of abbreviations on drawings and in text shall be in accordance with American National Standards Institute (ANSI) Y1.1 (1972). All references to and examples of keyed text and shading of drawings to demote hardware levels in FAA-D-2494/1 and FAA-D-2494/2 shall not apply to this procurement.

3.6.33.2.2.1 Manuscript reference designations.- The reference diagrams, symbols, and abbreviations used in the manuscripts shall conform to the requirements of paragarph (3.6.27.7) therein. Also, the last two sentences of paragraph 1-3.5.4 of FAA-D-2494/1 shall not apply to this procurement. Digital logic diagrams shall conform to the requirements of FAA-STD-010 except that American National Standards Institute (ANSI) Y32.14 (1973) shall be used in lieu of MIL-STD-806B. The distinctive symbol shapes of Y32.14 shall be used wherever possible. The symbols used shall reflect the actual logical function of the circuitry. Thus, the NAND gate used as a NOR with active low-level input signals, shall be shown as an OR symbol with "bubbled" (active low) inputs. Each discrete logic gate shall be shown the detailed drawings with all of its input and output signals and their mnemonics. Thus, an inverter driving a NAND gate shall be drawn as such, not as a NAND date with one inverted (bubbled) input. All mnemonics shall have the same number of characters and each shall indicate whether a logic high or a logic low is the active (true) condition for that signal.

3.6.33.2.2.2 Standard safety notices.- The standard safety notices specified in paragraph 1-3.7.6.1 of FAA-D-2494/1 shall be used, except where modification to the wording is required to suit the equipment capabilities and the maintenance concept (e.g., removal of CCA's with power on>. Under no circumstances, however, does this exception permit an unsafe procedure to be utilized in operating or maintaining SSR/DMTI equipment.

3.6.33.2.2.3 General description.- The general description in section 1 of the instruction book shall be in accordance with the requirements of FAA-D-2494, paragraph 1-3.8.2.

3.6.33.2.2.4 Technical description.- The technical description in section 2 of the instruction book shall be in accordance with paragraph 1-3.9 and related subparagraphs of FAA-D-2494/1 as modified and limited herein.

3.6.33.2.2.4.1 Theory of operation.- The theory of operation of the equipment's hardware shall be presented in three distinct levels. The first level shall be a complete and detailed description of the signal flow and information exchange between SSR/DMTI modules and between the SSR/DMTI equipment and the associated external equipment. This level of theory, in conjunction with the general description of section 1, shall suffice to completely describe the overall SSR/DMTI system, including the major functions of each module, the system level and module level data paths and all interconnection details necessary to interface the SSR/DMTI to its associated radar equipment.

The second or intermediate level shall describe the major function signal flow and control features for each module. This level shall provide all of the information necessary for "remove and replace" troubleshooting on the system level and the module level. The third and most detailed level shall contain all of the information necessary for understanding the detail functions of each module and the circuit and logic details at the functional level. The operation of all ROM controller circuits, if used, must be completely described including such data as state diagrams, flow charts, and ROM chip program listings (data vs. address).

3.6.33.2.2.1 Manuscript reference designations.- The reference diagrams, symbols, and abbreviations used in the manuscripts shall conform to the requirements of paragarph (3.6.27.7) therein. Also, the last two sentences of paragraph 1-3.5.4 of FAA-D-2494/1 shall not apply to this procurement. Digital logic diagrams shall conform to the requirements of FAA-STD-010 except that American National Standards Institute (ANSI) Y32.14 (1973) shall be used in lieu of MIL-STD-806B. The distinctive symbol shapes of Y32.14 shall be used wherever possible. The symbols used shall reflect the actual logical function of the circuitry. Thus, the NAND gate used as a NOR with active low-level input signals, shall be shown as an OR symbol with "bubbled" (active low) inputs. Each discrete logic gate shall be shown the detailed drawings with all of its input and output signals and their mnemonics. Thus, an inverter driving a NAND gate shall be drawn as such, not as a NAND date with one inverted (bubbled) input. All mnemonics shall have the same number of characters and each shall indicate whether a logic high or a logic low is the active (true) condition for that signal.

3.6.33.2.2.2 Standard safety notices.- The standard safety notices specified in paragraph 1-3.7.6.1 of FAA-D-2494/1 shall be used, except where modification to the wording is required to suit the equipment capabilities and the maintenance concept (e.g., removal of CCA's with power on>. Under no circumstances, however, does this exception permit an unsafe procedure to be utilized in operating or maintaining SSR/DMTI equipment.

3.6.33.2.2.3 General description.- The general description in section 1 of the instruction book shall be in accordance with the requirements of FAA-D-2494, paragraph 1-3.8.2.

3.6.33.2.2.4 Technical description.- The technical description in section 2 of the instruction book shall be in accordance with paragraph 1-3.9 and related subparagraphs of FAA-D-2494/1 as modified and limited herein.

3.6.33.2.2.4.1 Theory of operation.- The theory of operation of the equipment's hardware shall be presented in three distinct levels. The first level shall be a complete and detailed description of the signal flow and information exchange between SSR/DMTI modules and between the SSR/DMTI equipment and the associated external equipment. This level of theory, in conjunction with the general description of section 1, shall suffice to completely describe the overall SSR/DMTI system, including the major functions of each module, the system level and module level data paths and all interconnection details necessary to interface the SSR/DMTI to its associated radar equipment.

The second or intermediate level shall describe the major function signal flow and control features for each module. This level shall provide all of the information necessary for "remove and replace" troubleshooting on the system level and the module level. The third and most detailed level shall contain all of the information necessary for understanding the detail functions of each module and the circuit and logic details at the functional level. The operation of all ROM controller circuits, if used, must be completely described including such data as state diagrams, flow charts, and ROM chip program listings (data vs. address).

(a) The term "device" in paragraph 1-3.9.2.2 of FAA-D-2494/1 shall include CCA's and other plug-in or wired-in assemblies, or units of similar complexities.

(b) Logic circuit diagrams shall show the multiple circuits or functions of integrated circuits and similar devices as separate logic blocks or components in lieu of one-for-one relationship specified in paragraph 1-3.9.2.5 of FAA-D-2494/1. The multiple blocks shall be distinguished with letter suffixes to facilitate identification (e.g., U2A, U2B, etc.). In the event that the functions of a logic chip are used in one function and the remaining bit is spare or is used elsewhere, the logic diagram representations of each part of the chip shall indicate which part of the chip (which bits, in this example) are used in each function.

(c) All multisheet logic and schematic diagrams shall have sheet-to-sheet mapping which permits a signal tracing in both directions. All lines entering or leaving a diagram must have mnemonics or other signal names and all appropriate source or destination sheet numbers. Signals leaving or entering via connectors, jacks, or plubs must have the connector, jack, and plug reference designations, pin numbers and cable numbers as applicable. An indication of the direction of the information flow shall be the edge of the diagram and shall be independent of any connector symbology. All third-level diagrams shall have alphanumeric zone coordinations consisting of equally spaced alphabetical divisions along the left-hand border and equally spaced numerical divisions along the top border. The signal mapping shall use the zone references, and the first associated theory text shall include the zone references at the first mention of a signal, circuit, or component.

(d) All components shown on simplified or intermediate diagrams shall be identified by reference designations to permit ready reference to the same components on the associated detailed diagrams. Signal names shall also be cross-referenced for the same reason. The detailed logic and schematic diagrams shall include complete and specific reference designations for each component. Each component shall be identified by a value or a part number (e.g., 400K, SN404, etc.) as applicable. Large scale integrated circuit chips shall be identified by function (RAM, CPU, adder, etc.). Each component in a detailed diagram shall have all of its signal pin connections shown, even those that are grounded or not used, and all signal lines shall be fully identified. The detailed logic diagrams shall not be annotated with verb noun statements as specified in paragraph 1-3.9.2.5.2 of FAA-D-2494/1.

(e) Complex self-text circuits shall be shown as separate functions on separate diagrams.

(f) The schematic diagram or logic diagram or both for a CCA's or other plug-in assembly shall be shown on a page or pages immediately preceding the circuit board (baseboard) illustrations, in lieu of the requirements of the last sentence of paragraph 1-3.9.2.8 of FAA-D-2494/1.

(g) Wiring diagrams and lists shall shown all cables, wiring, conductors, connectors, plugs, jacks, sockets, and pins, in addition to the information required by paragraph 1-3.9.2.10 of FAA-D-2494/1.

(h) In lieu of the requirements of paragraph 1-3.9.3.7 of FAA-D-2494/1, each functional entity such as an amplifier stage, a logic comparator, a memory, etc., shall be identified by an appropriate functional stage name. The name shall be written in full or abbreviated. Single components shall be identified by their reference designations.

(i) In lieu of the requirements of paragraph 1-3.9.3.8 of FAA-D-2494/1, the drawings shall be identified as specified herein. All detailed drawings which show a portion of more than one CCA's or similar physically partitioned assembly of the same or greater approximate complexity shall use dashed outlines to clearly shown the physical boundaries of such assemblies. Thus, components on a plug-in assembly shall be enclosed by a dashed outline to distinguish the assembly from the next higher assembly or module. Each hardware assembly or portion thereof which is shown on a diagram, even if not shown in conjunction with other levels, shall be identified by official nomenclature (FAA type number), if applicable, and by reference designation and the manufacturer's assembly or part number. These requirements also apply to modules, cabinets and similar items in higher-level diagrams, although the dashed lines are not required if the required delineation of units can be clearly presented without them.

(j) The use of equivalent circuits, as permitted by paragraph 1-3.9.5 of FAA-D-2494/1, shall be subject to the individual approval by the Government during the review of the manuscript.

(k) In lieu of the requirements of paragraph 1-3.14.5.1 of FAA-D-2494/1, individual components within analog or linear integrated circuits need not be shown on the maintenance diagrams, provided that sufficient information is presented to permit adequate troubleshooting and provided that the chip's circuit diagram is available elsewhere within the instruction book.

(l) Notes shall be provided on each diagram as necessary to explain conditions shown, to clarify special symbol or signal conventions or to identify differences between equipment configuration.

(m) X-ray type views of wiring connections for all printed circuit type boards used shall be provided. For all wire wrap assemblies of any type, tabular wiring string sequential connecting data shall be provided, indexed by mnemonic signal label, indicating successive string connection points, with special notation for signal source connection within the string.

3.6.33.2.2.5 Fault isolation procedures.- Paragraph 1-3.14.6.4 of FAA-D-2494/1 is modified to require the isolation methods and procedures to be in accordance with the approved maintenance concept and maintenance program plan. The procedures shall enable fault isolation to the Lowest Replaceable Unit (LRU). Automatic test equipment and procedures shall be used as much as possible. The procedures shall also be structured to minimize the system out-of-service time.

3.6.33.2.2.6 Installation, integration, and checkout.- The instruction book shall not contain the information required in paragraph 1-3.16 and related subparagraphs of FAA-D-2494/1 since the information is to be provided in the installation documents and as-built drawings required in 3.6.33.17 and 3.6.33.1.8 herein. Section 9.0 of the instruction book shall contain suitable cross-reference to these separate documents.

3.6.33.2.3 Drawings and Technical Memoranda.- The contractor shall maintain an index of all drawings, and technical documentation produced in connection with the design, fabrication, and test of the equipment. This index Shall be updated and copies provided to the Government with the management reports (3.6.33.1.1.1). All drawings submitted by the contractor shall meet the requirements of FAA-STD-002 except that contractor drawing numbers may Se used.

3.6.33.2.4 Provisioning Technical Documentation.- Provisioning technical documentation shall be supplied in accordance with FAA-G-1210 as established in the contract schedule.

3.6.33.2.4.1 SSR/DMTI Special Test Equipment hardware Supplement Manual.- The contractor shall prepare and deliver a special test equipment hardware supplement to the Operationa and Maintenance Technical Manual for the Autek Model 5810A Automatic Test System, publication number 465-0757 dated June 1982. The supplement shall describe the test hardware (3.6.28.2.1.3) and shall contain sections on 1) General Information and Requirements, 2) Technical Description, 3) Operation, 4) Standards and Tolerances, 5) Periodic Maintenance, 6) Maintenance Procedures, 7) Corrective Maintenance, 8) Parts List, 9) Installation, Integration, and Checkout, 10) Troubleshooting Support Data, 11) Computer Software. Only one level of theory discussion is required.

(m) X-ray type views of wiring connections for all printed circuit type boards used shall be provided. For all wire wrap assemblies of any type, tabular wiring string sequential connecting data shall be provided, indexed by mnemonic signal label, indicating successive string connection points, with special notation for signal source connection within the string.

3.6.33.2.2.5 Fault isolation procedures.- Paragraph 1-3.14.6.4 of FAA-D-2494/1 is modified to require the isolation methods and procedures to be in accordance with the approved maintenance concept and maintenance program plan. The procedures shall enable fault isolation to the Lowest Replaceable Unit (LRU). Automatic test equipment and procedures shall be used as much as possible. The procedures shall also be structured to minimize the system out-of-service time.

3.6.33.2.2.6 Installation, integration, and checkout.- The instruction book shall not contain the information required in paragraph 1-3.16 and related subparagraphs of FAA-D-2494/1 since the information is to be provided in the installation documents and as-built drawings required in 3.6.33.17 and 3.6.33.1.8 herein. Section 9.0 of the instruction book shall contain suitable cross-reference to these separate documents.

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(c) The manual shall provide a detailed explanation of hardware related programming factors such as input and output formats, codes, bit arrangements for control characters, communication sequences, and both normal and error interrupt processing.

(d) The manual shall completely describe the changes, if any, to the 5810A's system software (3.6.28.2.1.1). This description shall cover definition, construction, use, nomenclature and limitations of each modified or new instruction or function.

(e) For each test program the manual shall provide a narrative description, specification of the program input, outputs and their definitions; a list of all flags; and the test methods and algorithms used to test the SSR/DMTI assembly. The Contractor shall provide specifications in this section showing table definitions, storage allocation and identification or reserved registers. For each program, the contractor shall provide detailed flow charts as necessary to fully explain and describe the operation and flow of the test program.

(f) The manual shall provide for each test routine complete program listings, including step-by-step comments to describe the code.

3.6.33.2.6 Configuration management plan.- The contractor shall prepare and submit a configuration management plan in accordance with paragraph 3.2 and 10.2(c), FAA-STD-021 within 60 calendar days after contract award to the Contracting Officer for approval. The Government will have 30 calendar days to approve or disapprove. If required, the contractor will submit a revised plan to the Contracting Officer within 30 calendar days of receipt of Government comments.

4. QUALITY ASSURANCE PROVISIONS

4.1 Quality control program.- The contractor shall establish and maintain a Quality Control Program in accordance with FAA-STD-013 and the contractor's Quality Control Program Plan (QCPP) as approved by the Government. The QCPP shall describe the contractor's provision for control, inspection, and test of all items required by the contract, including site installation, in accordance with the terms of the contract, including but not limited to the contract, specifications, and FAA-STD-013.

4.2 General.- The contractor shall provide the test facilities, instrumentation and services which are acceptable to the Government and that are required to perform the tests specified herein. All of the tests shall be conducted by the contractor in accordance with the test methods in the Government approved test plans and procedures (3.6.33.1.3). The tests shall demonstrate the equipment's compliance with all of the requirements of this specification. The following tests, as a minimum, shall be conducted:

(c) The manual shall provide a detailed explanation of hardware related programming factors such as input and output formats, codes, bit arrangements for control characters, communication sequences, and both normal and error interrupt processing.

(d) The manual shall completely describe the changes, if any, to the 5810A's system software (3.6.28.2.1.1). This description shall cover definition, construction, use, nomenclature and limitations of each modified or new instruction or function.

(e) For each test program the manual shall provide a narrative description, specification of the program input, outputs and their definitions; a list of all flags; and the test methods and algorithms used to test the SSR/DMTI assembly. The Contractor shall provide specifications in this section showing table definitions, storage allocation and identification or reserved registers. For each program, the contractor shall provide detailed flow charts as necessary to fully explain and describe the operation and flow of the test program.

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4.2 General.- The contractor shall provide the test facilities, instrumentation and services which are acceptable to the Government and that are required to perform the tests specified herein. All of the tests shall be conducted by the contractor in accordance with the test methods in the Government approved test plans and procedures (3.6.33.1.3). The tests shall demonstrate the equipment's compliance with all of the requirements of this specification. The following tests, as a minimum, shall be conducted:

Function

(h) DMTI equipment performance
(i) Not used
(j) Power supply performance
(k) Operation of switching functions
(l) Master/slave operation
(m) All meter readings
(n) Comparison of waveforms at all AC or pulse test points (with standard set of waveform photographs)
(o) Measurement of voltage at all DC test points

The electrical service conditions test shall be conducted in accordance with paragraph 4.8 and 4.11 of FAA-G-2100 and the requirements herein. A test at each extreme of line frequency shall be performed. With the line frequency at the design center value, tests shall be performed over the line voltage service condition range. The equipment's performance in the presence of specified electrical transients on the AC line shall be demonstrated by testing. The start-up surge and power consumption tests shall be accomplished under normal test conditions.

The contractor shall supply cabling of the appropriate type and the specified maximum length required for all output signals from the operational SSR/DMTI. The output signals shall be tested to verify that they meet the applicable requirements when the appropriate loads are connected to this cable.

4.3.3.3 Reliability test and demonstration.- The reliability test and demonstration shall be conducted in accordance with the reliability test plan (3.6.33.1.3.1) and the requirements herein. Reliability development testing shall be performed in accordance with paragraph 5.3.2 of MIL-STD-785. The development tests shall be designed to identify problem areas, detect latent defects, and underscore deficiencies such that the corrective actions required to cause incremental reliability growth can be implemented as the equipment development proceeds. Development test results and data shall be included in the reliability status reports (3.6.33.2.1.2).

A reliability demonstration test shall be conducted on the units specified in 4.1 herein to establish compliance with the specified MTBF and availability requirements of (3.6.30) herein. The test shall be conducted under normal test conditions and shall be in accordance with section 50, appendix B, MIL-STD-781 with no voltage, vibration or temperature cycling and temperature of 25 $\pm$ 5 degrees C (68°F to 86°F) and shall be conducted in accordance with Test Plan IV C, Appendix C, MIL-STD-781. The performance parameters of the production test and any other parameters necessary to adequately establish proper performance of the equipment shall be measured and recorded at least once every 12 hours. These parameters ahll be specified in the reliability test procedures (3.6.33.1.4).

The demonstration tests shall be conducted in accordance with appendix D of MIL-STD-781 except where otherwise required herein. The tests shall continue 24 hours per day, 7 days a week until an accept-reject decision can be made. During the tests, all preventive maintenance prescribed for normal operational deployment of the equipment shall be performed by the contractor. Data on all failures and corrective and preventive maintenance times shall be recorded during the test, even if the failures or maintenance tasks involved no loss of capability and, thus, are not counted as "failures" in the reliability test. This maintainability data is in addition to that required elsewhere herein.

4.3.3.4 Maintainability test.- The maintainability demonstration test shall be conducted in accordance with the approved test plan (3.6.33.1.3.2) and the requirements herein. The test shall be conducted under simulated operational conditions and shall establish whether or not SSR/DMTI meets the maintainability requirements of (3.6.30) herein, including MTTR but excluding bench repair time. The downtime shall begin with the loss or degradation of a capability to a user and shall stop with the restoration of the full capability to that user. Test Method 1, Test Plan B of MIL-STD-471, Appendix B, shall be used with a consumer's risk value of 0.10. Appropriate corrective maintenance tasks for each equipment shall be generated by fault simulation in accordance with paragraphs 4.3.1.2 and appendix A of MIL-STD-471. The number of tasks shall be as specified by paragraphs B.10.3 of MIL-STD-471 or 50, whichever is greater. The specific corrective maintenance tasks will be selected by the Government as a part of the test procedures (3.6.33.1.4). The preventive maintenance tasks tested shall consist of all those tasks prescribed for normal operational deployment of the equipment.

The tests shall 'be administered in accordance with the requirements of paragraph 4.4 of MIL-STD-471. The appropriate maintenance procedures described in the equipment instruction book (3.6.33.2.2) shall be followed as may be needed during the performance of each corrective or preventive maintenance task . Whenever possible, the maintenance activities shall be performed on the off-line channel or supporting equipment.

4.3.4 Type tests.- The type test shall demonstrate that the equipment functions correctly under the service condition requirements specified in paragraph 3.5.2 and its related subparagraphs herein. The type test shall be conducted in accordance with paragraph 4.3.3 of FAA-G-2100.

The barametric service condition test shall be in accordance with the requirements of paragraph 4.9 of FAA-G-2100 except that an actual test of the equipment's performance after at least 5 hours at each pressure extreme shall be performed. Normal temperature, humidity, and line voltage conditions are acceptable during the pressure test.

The temperature and humidity service condition test shall be conducted in accordance with paragraph 4.11 and all steps and subparagraphs of FAA-G-2100, except step 8.

The demonstration tests shall be conducted in accordance with appendix D of MIL-STD-781 except where otherwise required herein. The tests shall continue 24 hours per day, 7 days a week until an accept-reject decision can be made. During the tests, all preventive maintenance prescribed for normal operational deployment of the equipment shall be performed by the contractor. Data on all failures and corrective and preventive maintenance times shall be recorded during the test, even if the failures or maintenance tasks involved no loss of capability and, thus, are not counted as "failures' in the reliability test. This maintainability data is in addition to that required elsewhere herein.

4.3.3.4 Maintainability test.- The maintainability demonstration test shall be conducted in accordance with the approved test plan (3.6.33.1.3.2) and the requirements herein. The test shall be conducted under simulated operational conditions and shall establish whether or not SSR/DMTI meets the maintainability requirements of (3.6.30) herein, including MTTR but excluding bench repair time. The downtime shall begin with the loss or degradation of a capability to a user and shall stop with the restoration of the full capability to that user. Test Method 1, Test Plan B of MIL-STD-471, Appendix B, shall be used with a consumer's risk value of 0.10. Appropriate corrective maintenance tasks for each equipment shall be generated by fault simulation in accordance with paragraphs 4.3.1.2 and appendix A of MIL-STD-471. The number of tasks shall be as specified by paragraphs B.10.3 of MIL-STD-471 or 50, whichever is greater. The specific corrective maintenance tasks will be selected by the Government as a part of the test procedures (3.6.33.1.4). The preventive maintenance tasks tested shall consist of all those tasks prescribed for normal operational deployment of the equipment.

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The barametric service condition test shall be in accordance with the requirements of paragraph 4.9 of FAA-G-2100 except that an actual test of the equipment's performance after at least 5 hours at each pressure extreme shall be performed. Normal temperature, humidity, and line voltage conditions are acceptable during the pressure test.

The temperature and humidity service condition test shall be conducted in accordance with paragraph 4.11 and all steps and subparagraphs of FAA-G-2100, except step 8.

(e) All observations of malfunctioning or instability in the system shall be recorded on test data sheets (3.6.33.1.4) which shall serve as a log or history of the test. Entries into the log may be made by the Government representatives or the contractor. The contractor shall include proposed pass-fail criteria in the test plan which are consistent with the reliability requirements.

(f) All specification requirements shall be met during the test period without readjustment of controls, other than normal operational controls.

The production test shall also include an inspection of preservation, packaging, packing, and marking of material for shipment and storage to assure conformance with the requirements of section five herein.

4.3.6 Availability calculation.- The availability of the operational SSR/DMTI equipment shall be established using data from the reliability test and demonstration (4.3.3.3), the maintainability test (4.3.3.4), and the burn-in portion of the production tests (4.3.5). Only data taken during the time when the SSR/DMTI is operating shall be used for this calculation. System downtime as the result of routine, scheduled preventive maintenance shall not be counted, provided that the recovery requirements of (3.6.30.2) are met. The recovery shall be successfully demonstrated at least twice for each such preventive maintenance routine before its downtime is deducted from the total downtime.

4.3.7 Onsite acceptance test.- When required by the contract schedule, onsite acceptance test shall be performed by the contractor in accordance with approved test plans and the requirements herein. The test shall consist of at least the following:

(a) Onsite tests shall be performed on each radar channel when installation is complete on each channel and then system tests shall be performed when both channels are complete.

(b) The system must operate under test conditions for at least 24 hours after the tests on the individual channels are completed.

(c) Test data shall be recorded at least every 6 hours during the test. All observations of malfunction or instability shall be recorded in the test log.

(d) The Government representative(s) shall be permitted to make any number of entires into the log even if not concurred in by the contractor's representative.

(e) All observations of malfunctioning or instability in the system shall be recorded on test data sheets (3.6.33.1.4) which shall serve as a log or history of the test. Entries into the log may be made by the Government representatives or the contractor. The contractor shall include proposed pass-fail criteria in the test plan which are consistent with the reliability requirements.

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(c) Test data shall be recorded at least every 6 hours during the test. All observations of malfunction or instability shall be recorded in the test log.

(d) The Government representative(s) shall be permitted to make any number of entires into the log even if not concurred in by the contractor's representative.

4.3.7.2.3 Onsite test data.- The contractor shall furnish three complete sets of final test procedures and onsite test data for each system. The procedures and test data shall be indexed and bound in a binder and two copies furnished to the site before final acceptance of the system by the Government. The third copy shall be mailed to the FAA technical representative for the contract. The final onsite test data submitted by the contractor shall be coordinated with the Government technical representative to ensure that adequate information is included to permit the Government to issue a completed FAA Form 198 (Facility Equipment and Adjustment Data> to the site personnel.

4.3.8 Integration tests.- When required by the contract, the contractor shall adapt SSR/DMTI operational equipment to the parameters of the associated radar equipment in accordance with the NAS integration test procedures (3.6.33.1.10). During this test, all functions and combinations of functions shall be exercised. As many interfaces and functions shall be active for this test as facility operational requirements will permit.

5. PREPARATION OF DELIVERY.-

5.1 System and equipment deliveries.- The contractor shall package, pack, and ship all SSR/DMTI equipment so that it arrrives safely at its destination. The responsibility for meeting this requirement remains fully with the contractor until final acceptance of the equipment by the Government. The Government will not be responsible for packaging, packing, shipment, storage, or handling of the equipment before final acceptance is accomplished. Spare parts for equipment locations (3.6.29.1) shall be included with the equipment and are subject to the same delivery requirements as the equipment. Equipment for which contractor installation is not required by the contract shall be preserved, packaged, packed and marked in accordance with MIL-E-17555, Level A.

5.2 Depot spare parts deliveries.- To facilitate handling, storage, and distribution of spare parts provided to the FAA Depot, the contractor shall preserve and package the depot spare parts (3.6.29.2) in accordance with MIL-E-17555, Level A. The parts shall be packed and marked in accordance with MIL-E-17555, Level B.

6. NOTES

This section is not applicable to this specification.

FAA-E-2739
March 16, 1984

DEPARTMENT OF TRANSPORTATION

FEDERAL AVIATION ADMINISTRATION

SPECIFICATION

SOLID-STATE RECEIVER AND DIGITAL MOVING TARGET INDICATOR (DMTI) MODIFICATION KIT FOR VACUUM-TUBE AIR ROUTE SURVEILLANCE RADARS (VT ARSR)